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MINERAL RESOURCES

OF THE

UNITED STATES

1923

F. J. KATZ
Geologist in Charge, Division of Mineral Resources

PART I—METALS

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MINERAL RESOURCES OF THE UNITED STATES, 1923—PART I

THE MINERAL RESOURCES OF THE UNITED STATES IN 1923[1]

INTRODUCTION

By Frank J. Katz
Geologist in charge, Division of Mineral Resources

All the main branches of the mineral industry in 1923 showed marked improvement over the preceding years of depression, and several established new high records of production. The several elements of the industry were restored to or had gained over their pre-war vigor with probably only three notable exceptions—copper mining, through overdevelopment followed by curtailment of its market; precious-metal mining, by reason of depreciated purchasing power of its products; and bituminous-coal mining, from excessive capacity and overmanning. The year 1922 had on the whole been one of gradual betterment in tone of business despite the longest and most widespread strike in the annals of coal mining and a strike among the railroad shop crafts which for a few months seriously interfered with transportation. These difficulties had been overcome before the beginning of 1923, and throughout that year there was generally steady improvement in conditions affecting the mining industries.

The total value of mineral products of the United States in 1923 was about $6,000,000,000, an increase of 29 per cent over the value in 1922 and 45 per cent over that in 1921, but a decrease of 14 per cent from 1920, when prices were at the peak.

Soft-coal mining shared with other industries a continued recovery from the depression of 1921 and the early part of 1922, but the dominating influence in the market was the after effect of the great strike of the year before. Stocks of consumers at the beginning of the year were low—only 36,000,000 tons on January 1. Though above the danger point, this was not enough to conduce to a feeling of safety, and in consequence prices were high. The average spot price in January, according to Coal Age, was $4.38 a ton, against $2.25 in the corresponding month of 1922. Congestion of the railroads prevented rapid accumulation of reserves until the winter peak of consumption was passed, and distribution continued under nominal supervision by the Federal Fuel Distributor.

[1] In Mineral Resources of the United States the use of leaders (_____) indicates that so far as the Geological Survey has been able to ascertain there was nothing to report. If data are not available, the fact is indicated by a statement to that effect in a footnote. Leaders are also used in footings where it is quite evident that figures in a column are not addable and in other places where entries are not appropriate.

All figures of imports and exports in this report were compiled by J. A. Dorsey, of the Geological Survey, from records of the Bureau of Foreign and Domestic Commerce, Department of Commerce, having been converted by Mr. Dorsey to the various units of measurement used in this report and arranged by him in their present form. The imports are those for the calendar year unless otherwise stated. Wherever exports are shown, unless otherwise specified, the figures represent domestic products and not foreign minerals reexported, and they also cover calendar years.

Uncertainty of future supplies of bituminous coal was set at rest in January by the action of the operators and miners in renewing the wage agreement at the instance of the United States Coal Commission. The new agreement was to run until March 31, 1924. Nevertheless, active buying continued throughout the summer, as consumers sought to build up their depleted stocks. Especially heavy purchases were made by the railroads, partly because of an order issued by the Interstate Commerce Commission in June, abolishing the practice of assigning cars for railroad fuel, an order since temporarily suspended. The results of this heavy summer buying were remarkable. Production instead of showing its characteristic seasonal decline continued steadily throughout the year. The congestion of traffic, formerly so common in the fall, was thereby avoided, and the spot price, which had dropped to $2.56 in June—a level below the cost of production at many mines—continued to decline slowly throughout the year. In fact, by the end of the year severe depression had again descended upon the industry, and though production continued large, many mines were forced to close.

The total output for the year was nearly 564,600,000 short tons, a figure exceeded but twice in the history of the industry, making 1923 second only to 1918 and 1920. The average value of all the soft coal produced was $2.68 a ton.

In the anthracite trade also the controlling influence in 1923 was the after effect of the strike of 1922, intensified, however, by apprehension over another suspension when the existing agreement should expire. The great strike had left a deficit of 40 per cent in the supply of household anthracite. In the effort to make up the loss, operators and men joined to set new production records in the first quarter of the year. The output during the first quarter amounted to 25,298,000 short tons and for four weeks in that period exceeded 2,000,000 tons. Voluntary control of prices and distribution under authority of the Pennsylvania Public Service Commission and the Federal Fuel Distributor achieved conspicuous success but could not entirely prevent anxiety and distress in some communities of New England before the winter passed. Premium prices for the domestic sizes of independent operators and an active demand for the steam sizes therefore continued for several months. The anthracite wage agreement had been extended to expire September 1, 1923. Negotiations to renew it were begun early but ultimately deadlocked. Warnings by the United States Coal Commission that the public interest required a peaceful settlement yielded place to mediation by the governor of Pennsylvania. The principal feature of the settlement arranged was a 10 per cent increase in wages, and production continued with the loss of only a few days' time. Demand for domestic sizes continued active and absorbed the heavy tonnages offered, in spite of advances in price of 75 cents to $1 a ton, which were considered necessary to meet the higher wage. Demand for the steam sizes, on the contrary, began to drag, and sharp reductions in the prices of these sizes followed. In spite of the brief suspension the production for the year was one of the largest on record, second only to the figures for the war years 1917 and 1918.

The shortage of household fuel and the great activity of the iron and steel industry stimulated the production of coke, which rose

to 56,978,000 short tons, an amount slightly greater than the record set in the war year 1918. In 1923 by-product ovens contributed 66 per cent of the total coke-oven output and beehive ovens 34 per cent. The output of by-product coke set a new record. The year's production—37,598,000 tons—was an increase of 6,764,000 tons over the 1920 output, hitherto the maximum. One new plant began operation in 1923. The market for coal by-products was stimulated for a time by the shutting off of German supplies that followed the French occupation of the Ruhr, but the improvement due to this cause was offset by a decline in the price of benzol, which followed the price of gasoline and other petroleum products. The output of beehive coke in 1923 was 19,380,000 tons, more than twice as great as in 1922, when production in the Connellsville region had been curtailed by the coal miners' strike.

In 1923 all prior records were broken in the production of petroleum in the United States. The total was 732,407,000 barrels. This was an increase of 31 per cent over the production of 1922, was more than double the production of the United States in 1918, and was 37 million barrels more than the entire world produced in 1920. In addition to this tremendous domestic output, imports of crude petroleum, although considerably less than in 1922, amounted to 82 million barrels, and in spite of exports of 17 million barrels of crude oil and of unprecedented consumption (indicated deliveries to consumers were 714 million barrels), stocks of crude oil increased nearly 72 million barrels. At the end of the year stocks of crude petroleum, exclusive of consumers' stocks, amounted to 344,624,000 barrels, a supply sufficient for 172 days at the average daily rate of deliveries to domestic consumers plus exports for the year. On the last day of December over 33 million barrels of crude oil was held at refineries.

The increased output was due to flush yield from a number of highly productive new fields in California, Arkansas, Texas, and Oklahoma, marking the culmination of the discovery during the last six years of more than a score of extraordinarily large pools, among which are the Elk Hills, Sante Fe Springs, Long Beach, and Huntington Beach, in California; West Columbia, Hull, Ranger, Burkburnett, Mexia, and Powell, in Texas; Hewitt, Beggs, Bristow, Burbank, and Tonkawa, in Oklahoma; Homer and Haynesville, in Louisiana; Eldorado-Towanda, in Kansas; and El Dorado and Smackover, in Arkansas.

During 1923 the daily average production steadily increased from 1,676,000 barrels in January to a maximum of 2,161,000 barrels in November. The new California pools attained their maximum in September, but the Powell field, in Texas, which is estimated to have produced a maximum of 315,000 barrels a day, maintained production on so high a level that the peak for the entire country was not reached until November. The output of these fields, however, declined sharply in December, when the daily average decreased to 1,900,000 barrels, or less than that of April, a drop in daily average yield of 261,000 barrels.

Imports of crude oil in 1923 were 45 million barrels less than in 1922. This marks the first large decrease since imports began, in 1909, and emphasizes the changed conditions in Mexico due to the

falling off in the production of the Southern field, where so-called "light" oil is produced. A change in the sources of imported crude oil was evident in 1923, when over a million and a half barrels more than in 1922 was imported from other countries than Mexico, chiefly from Peru.

Decreased production and imports of Mexican petroleum, coinciding with the increased production in California, resulted in a novel feature in petroleum marketing—the shipment through the Panama Canal to Atlantic and Gulf ports in the United States of about 53 million barrels of California crude oil, having an average gravity of approximately 30° A. P. I. (0.8762), and the shipment of some 4 million barrels of California oil to Mexico. These unusual shipments of California crude oil, amounting to more than one-fifth of the State's production, greatly relieved the strained storage facilities.

Consumption continued to expand and, as measured by indicated deliveries to consumers (a calculated item that includes losses), increased from 592 million barrels in 1922 to about 714 million barrels in 1923, an increase of 21 per cent. For the first few months of the year indicated deliveries were greater than production, but later they did not keep pace with the increasing output, and from May to November they were less than production. The sharp reduction in production during December, however, reversed conditions, and deliveries to consumers were not only greater than production but were almost equal to the sum of production plus imports.

Prices of crude oil in 1923, reflecting the conditions of oversupply, trended downward. Toward the end of 1922 and during the first few months of 1923 prices of Mid-Continent oil, for example, in apparent accord with the slackening rate of increased supply, advanced, and on February 17 the price of petroleum of gravity between 33° and 34.9° was increased to $1.85 a barrel, as contrasted with $1.25 in December, 1922. But the increasing supply forced prices down, and on November 8 the price of Mid-Continent oil between 33° and 39.9° had declined to $1 a barrel, the low level reached during the period of deflation in 1921. However, on January 9, 1924, after the marked decline in production during December and apparently in anticipation of a decreasing supply, the price of Mid-Continent oil between 33° and 39.9° was increased to $1.25 a barrel. This advance followed advances in Pennsylvania grade crude oil from $2.50 to $3.25 a barrel, made during December.

The production of gold in 1923 was about as had been expected as the cost of mining siliceous ores of low grade did not decline sufficiently to stimulate mining to any large extent. The output was $51,734,000, an increase of 6 per cent over that of 1922 and the largest output since 1919. This increase was almost entirely due to a greater output of base metals recoverable from ore containing gold in Arizona, Utah, Idaho, and Montana, the increase of gold in those four States being nearly $4,200,000, while the output of gold in California, Alaska, South Dakota, and Colorado, which comes mainly from siliceous ore and placers, decreased nearly $2,350,000.

The production of silver in 1923 increased 17,095,000 ounces, or 30 per cent, over that in 1922, amounting to about 73,335,000 ounces, an output exceeded only in 1915 and 1916. Production was very large in the first six months of 1923, owing to the desire of domestic

miners and smelters to sell their silver under the Pittman Act. So much silver was sold that in June the Treasury announced that the amount to be repurchased under the act had been reached and thereafter ceased buying. After June the average price of silver was from 63.1 to 65.1 cents an ounce, slightly more than was expected, and the range of prices was unusually stable, owing to a steady demand from the Orient. It was lowest in August and highest in December. The average price of silver not derived from domestic mines was 65.2 cents an ounce in 1923, compared with 67.9 cents in 1922. The large increases in silver production in 1923 were made in those States that are large producers of copper and lead, such as Utah, Montana, Arizona, Nevada, and Idaho. The combined increase from these five States was nearly 17,000,000 ounces.

There was a tremendous increase in the smelter production of copper from domestic sources in 1923, 51 per cent more copper being produced than in 1922. The value of smelter production in 1923 increased 64 per cent. This increase in production was due mainly to the high prices prevailing during the first quarter of the year, as at the end of the year prices were at a lower level than the average for 1922. There was also a large increase in domestic consumption, which showed the highest rate since 1918 and except for that in the abnormal years 1916, 1917, and 1918 the highest recorded. Domestic production of new refined copper from domestic and foreign sources has kept pace with consumption and except for that in the years noted was also the highest recorded. For this reason, and also because of the unfavorable conditions in Europe, which have retarded consumption there, and the greatly increased production in South America and Africa, which has brought about increased competition for European and other markets, the price of copper is still below what the producers had expected. Costs of production have been cut by increased efficiency of operation and of labor, by consolidation of mining companies, and by closer cooperation between producers and manufacturers. Stocks of refined new copper increased from 216,000,000 pounds at the end of 1922 to 264,000,000 pounds at the end of 1923, and there was also an increase in stocks of blister copper and materials in process of refining. Exports of metallic copper amounted to 829,000,000 pounds in 1923, compared with 926,000,000 pounds in 1913, and general imports of unmanufactured copper to 676,000,000 pounds in 1923, compared with 409,000,000 pounds in 1913.

The price of zinc averaged 1 cent a pound higher in 1923 than in 1922, by virtue of which the industry was in an active condition through the year, smelter production proceeding at an even pace. The price started the year at 7 cents, rose in March to 8, then dropped to less than 6, and during the second half of the year ranged from 6¼ to 6½ cents. The general result was a good increase in the mine production of zinc (29 per cent) and a larger increase (44 per cent) in the smelter output of primary zinc. The largest increase in mine output was made in the Joplin region, which produced nearly 60 per cent of the total mine production of zinc in the country and made a gain of 28 per cent on its output for 1922. Oklahoma had the largest individual State output, with 242,000 tons of recoverable metal, a gain of 16 per cent on the output in 1922 and equal to 40 per cent of the country's mine output. This is more than any other

State has ever produced and, in fact, is more than the mine output of the whole country in 1908. Oklahoma was also first among the zinc-smelting States, but had a much smaller output than in her banner years during the World War. The output of zinc pigments and salts was about the same as in 1922, but the production of lithopone showed an encouraging increase of about 18 per cent.

Lead mining was more active in 1923 than in 1922, being stimulated by the higher price of lead, which averaged 1½ cents a pound above the average in 1922. This gain followed a steady rise through 1922 of 2½ cents a pound, which had put the lead industry in a thriving condition. In the early part of 1923 the price rose to 8.6 cents, but through most of the remainder of the year it was between 6 and 7 cents, coming back to 8 cents only at the end of the year. This fluctuation in price tended to discourage the reopening of old mines and any further expansion in development, so that spot lead was scarcely equal to the demand and the result was a near-panicky fear of a lead shortage, which early in 1924 forced the price up to 9 cents a pound. However, there was an increase of 15 per cent in the output of the mines in 1923, and of 16 per cent in the refinery output of primary lead. The principal gain in the mine production of lead was made in the Western States, to which Idaho and Utah made the greatest contribution; Colorado also made a big gain. The production of the Joplin region was slightly less than in 1922, and that of the southeastern Missouri district decreased 5 per cent. The strength of the foreign market led to a good increase in the exports of lead from warehouse and of articles under drawback. The year closed with record stocks of lead in ore and bullion in bonded warehouses. The sales of white lead declined 16 per cent, owing to high prices, but lead oxides increased 25 per cent in quantity and 20 per cent in average value.

The year 1923 was one of the most noteworthy years the iron and steel industry has known. A new record was made in the production of pig iron, and the output of steel fell only slightly short of equaling the record made in 1917. This increased activity was naturally reflected in iron-ore mining and resulted in a production that is the fourth highest in the history of the iron-ore industry, having been exceeded only by that of 1916, 1917, and 1918. There was an increase in the demand for manganiferous ore and low-grade manganese ore, but the larger part of the manganese ore used in making ferromanganese was imported. The consumption of limestone and fluorspar for fluxes increased, but this increase did not result in larger shipments of fluorspar, as the shipments to steel plants were about 20 per cent less than in 1922, the additional fluorspar being withdrawn from consumers' stocks or imported.

The tariff on manganese, which became effective September 22, 1922, stimulated domestic production in 1923, though the production of high-grade ores was considerably smaller than was generally hoped for. Domestic shipments (exclusive of fluxing ore) increased from 13,404 long tons in 1922 to 31,500 tons in 1923, but the average value of the ore shipped decreased, chiefly because of the high-grade ore shipped in 1923 a larger part than in 1922 contained only about 35

per cent of manganese, whereas most of that shipped in 1922 contained 45 to 53 per cent and therefore brought a higher price. Montana, as usual, shipped the largest quantity. Figures for gross weight of manganese ore imported have not been recorded by the Bureau of Foreign and Domestic Commerce since the change in the tariff, but the Survey estimates that the imports of such ore in 1923 were 419,000 long tons. These imports are less than those in 1918, when the domestic production was nearly 10 times as much as in 1923. In 1918 the production plus imports amounted to 797,000 long tons, compared with approximately 451,000 tons in 1923. These figures do not indicate a decrease in the requirements for manganese, however, for the production of steel almost equaled the production in the record year. The conditions thus shown are due to the facts that the imports of ferromanganese in 1923 were large and that manganese ore had been imported and stocked at the furnaces in 1922, prior to the date the new tariff went into effect.

Of the remaining metals of industrial importance, aluminum and arsenic were conspicuous in 1923, as they had been in 1922, by reason of large increases in production. The problem of arsenic supply continued to be of prime importance. During 1923 production was expanded to meet anticipated requirements, and production plus imports succeeded in keeping pace with the growth in demand. The close balance between supply and demand resulted in an increase in prices late in the year, when those consumers who had not early closed contracts with the larger producers began to buy eagerly. Of the total arsenic output 90 per cent came from lead and copper smelters. Of this amount only about one-half was a direct by-product from smelting lead and copper ores during the year, the remainder being derived from arsenical materials accumulated at the smelters through a number of years of operation and from the treatment of ores especially selected for an arsenic content higher than that in ores normally treated at the smelters. The older accumulations of flue dust and speiss were greatly depleted during the year and were practically exhausted during 1924, so that future supplies of arsenic from the smelters became dependent upon purchase of arsenical ores. Plants for the direct production of white arsenic showed increased output in 1923 and thereafter produced from ores treated directly for arsenic a much larger share of the total supply than they had before contributed.

In the field of production of nonmetallic minerals other than fuels sharp increase over the output of 1922 was general. This was the more noteworthy in that the production records for 1922 generally showed very considerable increases from 1921. As a result the rate of production in 1923 for most of these minerals was on a par with, and for some even exceeded, the peaks reached during the period of war stimulation. The minerals entering the chemical and metallurgical industries showed increases ranging from 5 per cent for common salt to 164 per cent for magnesite. Shipments of sulphur increased 20 per cent; the output of natural sodium salts (other than NaCl), 31 per cent; barite, 38 per cent; and chemical lime, 16 per cent. Shipments of fluorspar, chiefly flux, decreased 14 per cent. Among the fertilizer minerals phosphate rock increased 24 per cent

in shipments; potash, 70 per cent; and available lime in burned lime, pulverized limestone, and calcareous marl, used for agriculture, 5 per cent. The principal mineral materials used in the ceramic industries—clays, feldspar, glass sand, and silica of other varieties—showed moderate to large increases. The advance in the construction industries is reflected by increases in the mineral products they use, slate gaining 20 per cent; cement, 16 per cent; stone in general, 29 per cent; and sand and gravel, 48 per cent.

The abrasive materials as a whole showed a very large increase in 1923, and so also did graphite, mica, and fuller's earth.

SUMMARY

By Martha B. Clark

GENERAL TABLES

Mineral products of the United States in 1922 and 1923 [a]

Product	1922		1923		Percentage of increase or decrease	
	Quantity	Value	Quantity	Value	Quantity	Value
METALLIC						
Aluminum, pounds	----------	$13,622,000	----------	$28,305,000	----------	+108
Antimonial lead [b], short tons (2,000 pounds)	8,075	844,993	14,190	1,950,370	+76	+131
Antimony [c], do	1,441	[c] 156,000	2,170	[c] 338,500	+51	+117
Bauxite, long tons (2,240 pounds)	309,600	2,012,330	522,690	3,156,610	+69	+57
Cadmium, pounds	131,590	143,433	183,816	161,758	+40	+13
Chromite, long tons	355	7,288	227	3,819	−36	−48
Copper, [d] sales value, pounds	950,285,947	128,289,000	1,434,999,962	210,945,000	+51	+64
Ferroalloys, long tons	423,280	28,259,004	579,817	49,877,231	+37	+77
Gold [e], troy ounces	2,363,075	48,849,100	2,502,632	51,734,000	+6	+6
Iron:						
Ore [f], long tons	50,612,620	[f] 157,809,286	69,811,472	[f] 240,738,921	+38	+53
Pig, do	27,670,738	608,144,858	38,361,379	946,799,378	+39	+56
Lead (refined), [d] sales value, short tons	468,746	51,562,000	543,841	76,138,000	+16	+48
Manganese ore (35 per cent or more Mn) [g], long tons	15,682	472,501	32,269	880,178	+106	+86
Manganiferous ore (5 to 35 per cent Mn) [g], do	625,659	1,766,419	1,433,897	4,888,393	+129	+177
Nickel (value at New York City), short tons	208	133,191	100	71,605	−52	−46
Ores (crude), tailings, etc.:						
Copper, do	26,893,000	[h]	45,573,000	[h]	+69	----------
Copper-lead and copper-lead-zinc, do	52,000	[h]	162,000	[h]	+212	----------
Dry and siliceous (gold and silver), do	8,728,000	[h]	9,122,000	[h]	+5	----------
Lead, do	7,288,000	[h]	7,613,000	[h]	+4	----------
Lead-zinc, do	8,555,000	[h]	10,987,000	[h]	+28	----------
Zinc, do	2,667,000	[h]	4,064,000	[h]	+52	----------
Platinum and allied metals (value at New York City), troy ounces	57,718	5,932,726	49,797	5,762,305	−14	−3
Quicksilver (value at San Francisco), flasks (75 pounds net)	6,375	368,348	7,937	521,302	+25	+42

[a] In this general statement certain of the figures represent shipments rather than quantity mined. The reader is referred to the following sections on the various mineral products for information in greater detail than it seems practicable to give here.

[b] From both domestic and foreign ores.

[c] Content of antimonial lead. None from other sources. Values excluded from metallic totals as the values of the antimony are included in the antimonial lead values.

[d] Product from domestic ores only.

[e] Value, $20.671834625323 an ounce.

[f] Value not included in total value.

[g] Including ore used for fluxing. For separation see pp. 67A–68A.

[h] Figures showing values not available.

Mineral products of the United States in 1922 and 1923—Continued

Product		1922		1923		Percentage of increase or decrease	
		Quantity	Value	Quantity	Value	Quantity	Value
METALLIC—continued							
Quicksilver ore	short tons	43,000	[h]	51,000	[h]	+19	
Silver	troy ounces	56,240,048	$56,240,048	73,335,170	$60,134,839	+30	+7
Tin (metallic equivalent)	pounds	2,800	912	3,782	1,623	+35	+78
Titanium ore (rutile)	short tons	310	[i]	270	[i]	−13	
Tungsten ore (60 per cent concentrates)	do			241	144,600		
Uranium and vanadium ores	do	929	166,016	2,025	150,000	+118	−10
Zinc,[d] sales value	do	353,274	40,273,000	508,335	69,134,000	+44	+72
Total value of metallic products (approximate)			987,180,000		1,510,800,000		+53
NONMETALLIC							
Arsenious oxide	short tons	10,027	1,475,229	14,271	2,808,801	+42	+90
Asbestos	do	67	10,120	227	9,626	+239	−5
Asphalt	do	1,132,937	12,639,105	1,395,890	15,945,805	+23	+26
Barytes (crude)	do	155,040	1,123,950	214,183	1,664,156	+38	+48
Borates	do	85,220	2,705,140	136,650	3,994,790	+60	+48
Bromine	pounds	1,005,174	150,668	842,352	146,176	−16	−3
Calcium-magnesium chloride	short tons	33,067	571,326	44,961	663,384	+36	+16
Cement	barrels (376 pounds net)	118,590,644	208,464,028	137,183,792	259,631,776	+16	+25
Clay:							
Products			[j] 321,494,403		[j] 424,582,628		+32
Raw [f]	short tons	2,647,700	[f] 8,330,514	3,434,660	[f] 11,188,913	+30	+34
Coal:							
Bituminous [k]	do	422,268,099	1,274,820,000	564,564,662	1,514,621,000	+34	+19
Pennsylvania anthracite	long tons	48,824,127	273,700,125	83,338,401	506,786,768	+71	+85
Coke [f]	short tons	37,124,012	[f] 238,313,323	56,977,534	[j] 373,496,898	+53	+57
Diatomaceous (infusorial) earth and tripoli	do	74,966	703,397	92,915	1,082,163	+24	+54
Emery	do	1,468	17,511	2,286	29,478	+56	+68
Feldspar (crude)	long tons	117,127	844,568	145,004	1,057,595	+24	+25
Fluorspar	short tons	141,596	2,531,165	121,188	2,505,819	−14	−1
Fuller's earth	do	138,944	2,289,719	149,134	2,247,523	+7	−2
Garnet for abrasive purposes	do	7,054	566,879	9,006	688,437	+28	+21
Gems and precious stones			71,106		65,000		−9
Graphite:							
Amorphous	short tons	2,200	[i]	4,056	39,560	+84	
Crystalline	pounds	1,849,766	85,242	3,964,900	151,434	+114	+78
Grindstones and pulpstones	short tons	26,524	1,020,186	46,570	1,689,315	+76	+66
Gypsum	do	3,779,949	29,361,151	4,753,448	34,888,155	+26	+19
Lime	do	3,639,617	33,255,039	4,076,243	39,993,652	+12	+20
Magnesite (crude)	do	55,790	571,745	147,250	1,103,700	+164	+93

Mica:						
Scrap	do	6,641	114,045	8,054	129,695	+21	+14
Sheet	pounds	1,077,908	194,301	2,063,179	311,180	+91	+60
Millstones			20,853		22,229		+7
Mineral paints:							
Natural pigments [m]	short tons	(m)	(m)	(m)	(m)	(m)	(m)
Zinc and lead pigments [n]	do	162,815	22,205,400	163,240	23,660,381	+.3	+7
Mineral waters	gallons sold	38,492,881	5,498,269	44,430,998	6,493,177	+15	+18
Natural gas	M cubic feet	762,546,000	221,535,000	1,008,135,000	239,966,000	+32	+8
Natural-gas gasoline	gallons	505,832,000	72,711,063	816,226,000	77,268,000	+61	+6
Oilstones, etc	short tons	1,016	197,450	1,223	231,812	+20	+17
Peat	do	60,680	397,729	61,355	376,834	+1	−5
Petroleum	barrels (42 gallons)	557,531,000	895,111,000	732,407,000	978,430,000	+31	+9
Phosphate rock	long tons	2,417,883	10,482,846	3,006,706	11,576,049	+24	+10
Potash (K_2O)	short tons	11,313	463,512	19,281	784,671	+70	+69
Pumice	do	45,262	175,600	56,575	214,169	+25	+22
Pyrites	long tons	169,042	671,241	181,628	661,000	+7	−2
Salt	short tons	6,792,849	27,464,838	7,130,713	27,795,941	+5	+1
Sand:							
Glass	do	1,768,549	2,866,366	2,034,958	3,751,778	+15	+31
Molding, building, etc., and gravel	do	93,098,497	61,751,298	137,897,195	87,151,876	+48	+41
Sand-lime brick	thousands	(o)	(o)	[i] 213,425	[i] 2,471,536		
Silica (quartz)	short tons	10,653	101,347	20,601	193,630	+93	+91
Slate	do	607,680	9,176,784	726,800	12,076,624	+20	+32
Stone	do	80,211,560	122,066,928	103,327,460	159,947,241	+29	+31
Sulphur	long tons	1,343,624	22,000,000	1,618,841	26,000,000	+20	+18
Sulphuric acid (60° Baumé) from copper and zinc smelters	short tons	(o)	(o)	[p] 785,789	[p] 6,209,157		
Talc and soapstone	do	198,684	2,859,897	196,692	3,012,253	−1	+5
Total value of nonmetallic products (approximate)			3,656,410,000		4,485,130,000		+23
SUMMARY							
Total value of metallic products			987,180,000		1,510,800,000		+53
Total value of nonmetallic products (exclusive of mineral fuels)			918,530,000		1,168,060,000		+27
Total value of mineral fuels			2,737,880,000		3,317,070,000		+21
Total value of "unspecified" (metallic and nonmetallic) products (partly estimated) [q]			3,700,000		[q] 4,030,000		+9
Grand total approximate value of mineral products			4,647,290,000		5,999,960,000		+29

[d] Product from domestic ores only.
[f] Value not included in total value.
[h] Figures showing values not available.
[i] Value included in total value of metallic products. Survey not at liberty to publish figures.
[j] Canvass discontinued by Geological Survey after 1920. Figures obtained through cooperation with Bureau of Census.
[k] Includes brown coal and lignite, and anthracite mined elsewhere than in Pennsylvania.
[l] Value included in total value of nonmetallic products. Survey not at liberty to publish figures.
[m] Canvass discontinued after 1915. Value of iron ore sold for paint included under last item ("Unspecified").
[n] Sublimed blue lead, sublimed white lead, leaded zinc oxide, and zinc oxide.
[o] No canvass for 1922. Estimate of value included in total value of nonmetallic products.
[p] According to Bureau of the Census.
[q] Includes in 1923 the value of bismuth, cadmium sulphide, chats ($185,000), columbite ($540), flint lining for tube mills, ilmenite, iron ore sold for magnets, iron ore sold for paint ($140,306), lithium minerals ($38,800), magnesium, natural magnesium chloride, natural magnesium sulphate ($231,000), marls ($460,055), molybdenum, pebbles for grinding, selenium ($134,400), silica sand and sandstone, finely ground ($643,154), sodium salts (sodium carbonate, sodium bicarbonate, sodium sulphate, and trona) from natural sources ($851,850), tellurium, zircon ($21,420), and an estimate of the value of miscellaneous mineral products, statistics for which are not collected annually by the Survey.

Total value of mineral products of the United States from 1880 to 1923

Year	Metallic		Nonmetallic		Unspecified (metallic and nonmetallic)	Total	
	Value	Percentage of increase or decrease	Value	Percentage of increase or decrease		Value	Percentage of increase or decrease
1880–1912 [a]	$13,713,271,000		$19,093,596,000		$55,488,000	$32,862,355,000	
1913	878,869,000	+2	1,554,298,000	+13	378,000	2,433,545,000	+9
1914	686,639,000	−22	1,424,063,000	−8	470,000	2,111,172,000	−13
1915	991,730,000	+44	1,400,484,000	−2	2,430,000	2,394,644,000	+13
1916	1,620,745,000	+63	1,884,413,000	+35	3,281,000	3,508,439,000	+47
1917	2,086,234,000	+29	2,900,462,000	+54	5,800,000	4,992,496,000	+42
1918	2,153,318,000	+3	3,380,690,000	+17	6,700,000	5,540,708,000	+11
1919	1,359,744,000	−37	3,232,626,000	−4	3,400,000	4,595,770,000	−17
1920	1,762,350,000	+30	5,214,170,000	+61	4,820,000	6,981,340,000	+52
1921	654,130,000	−63	3,481,720,000	−33	2,650,000	4,138,500,000	−41
1922	987,180,000	+51	3,656,410,000	+5	3,700,000	4,647,290,000	+12
1923	1,510,800,000	+53	4,485,130,000	+23	4,030,000	5,999,960,000	+29
Grand total	28,405,010,000		51,708,062,000		93,147,000	80,206,219,000	

[a] For totals by years prior to 1913 see Mineral Resources, 1920.

Value of mineral products of the United States, 1919 to 1923, by States [a]

State	1919	1920	1921	1922	1923
Alabama	$65,540,376	$86,289,575	$52,269,451	$61,723,268	$82,496,430
Alaska	19,616,909	23,396,114	17,041,057	19,506,610	20,241,137
Arizona	112,512,239	116,383,335	30,818,363	63,737,720	104,940,213
Arkansas	10,709,213	17,813,328	22,515,412	31,418,633	41,954,319
California	213,823,488	269,404,686	297,025,679	283,411,997	381,010,424
Colorado	59,953,279	76,037,896	54,045,056	54,806,277	61,379,146
Connecticut	5,152,124	6,326,326	4,219,457	5,346,295	7,177,266
Delaware	390,706	359,833	379,785	428,314	416,074
District of Columbia	105,623	369,534	411,745	869,132	929,768
Florida	10,513,495	22,923,780	12,597,948	10,907,718	12,557,822
Georgia	9,429,972	12,178,695	8,650,003	11,120,018	14,300,313
Idaho	19,044,567	32,449,783	16,502,273	18,495,628	27,105,344
Illinois	213,701,212	373,926,540	254,019,136	244,617,561	285,569,638
Indiana	82,270,784	146,736,294	97,700,676	108,394,095	132,179,525
Iowa	37,882,183	57,250,480	35,639,505	36,205,251	46,174,897
Kansas	120,759,783	198,097,758	113,098,346	103,884,561	110,685,713
Kentucky	110,305,840	195,920,036	114,404,662	158,701,496	148,853,786
Louisiana	38,851,509	138,745,725	61,061,974	75,519,328	61,199,048
Maine	4,073,870	5,428,086	4,392,039	5,588,140	7,565,553
Maryland	18,345,024	30,944,378	16,083,965	14,905,227	21,189,542
Massachusetts	10,070,543	12,411,708	9,835,107	11,004,523	14,781,129
Michigan	122,973,774	166,338,818	69,452,819	101,430,981	128,291,450
Minnesota	131,529,797	177,589,967	72,609,973	111,617,448	174,105,328
Mississippi	1,628,031	2,201,246	1,954,353	1,600,393	2,163,343
Missouri	61,862,232	90,994,479	56,375,543	62,402,642	79,199,473
Montana	73,630,824	85,885,403	30,161,734	59,400,591	74,707,269
Nebraska	7,658,424	7,168,424	2,366,287	2,996,587	3,302,397
Nevada	24,457,735	25,648,961	14,038,071	18,374,023	28,598,627
New Hampshire	2,294,959	2,986,485	2,234,607	2,283,119	3,572,615
New Jersey	56,898,033	72,335,207	47,429,290	62,396,379	72,602,066
New Mexico	22,679,960	27,883,565	13,227,268	18,038,022	23,791,047
New York	56,779,564	78,431,317	62,502,458	73,527,880	89,975,134
North Carolina	6,223,953	7,760,482	5,456,479	7,268,381	10,020,559
North Dakota	2,413,025	3,078,548	2,500,349	3,693,095	3,473,018
Ohio	214,829,888	355,844,499	223,533,658	236,808,638	287,868,728
Oklahoma	291,078,174	493,320,359	269,882,786	369,069,612	398,857,652
Oregon	3,962,822	5,496,253	5,199,803	5,489,956	6,054,487
Pennsylvania	918,048,917	1,314,332,585	944,688,650	823,148,222	1,225,036,404
Rhode Island	853,981	1,175,653	922,765	770,966	1,022,528
South Carolina	2,370,916	2,825,479	1,754,491	2,414,346	3,550,059
South Dakota	5,842,704	5,950,878	7,498,656	7,278,934	7,372,368
Tennessee	37,134,899	55,023,232	33,754,823	35,146,266	41,553,789
Texas	190,563,015	371,250,979	212,302,907	249,604,173	264,232,465
Utah	64,165,525	76,536,657	40,595,872	60,697,116	86,221,000
Vermont	11,728,052	15,008,894	10,650,213	9,576,636	13,910,449
Virginia	36,799,407	60,161,247	32,810,842	38,551,479	48,052,018
Washington	18,267,938	26,677,191	17,605,878	19,725,203	22,169,191
West Virginia	298,168,194	547,872,937	316,180,647	358,772,116	412,866,535
Wisconsin	18,772,601	19,630,114	9,990,961	13,822,883	19,089,600
Wyoming	41,097,209	83,034,397	51,365,150	58,529,284	77,664,547

[a] In this table iron ore, not pig iron, is taken as the basis of valuation of iron, and in the case of other metals mine production (recoverable content of metals) is the basis.

Rank in value	Product	Principal producing States [a]	
		In order of quantity	In order of value
20	Aluminum		New York, North Carolina, Tennessee.
40	Antimonial lead	Not separable by States	Not separable by States.
88	Antimony ore	Arkansas	Rank same as for quantity.
36	Arsenious oxide	Nevada, Utah, Montana	Do.
84	Asbestos	Georgia, California, Maryland, Arizona	Maryland, California, Georgia, Arizona.
24	Asphalt	California, Texas, Kentucky, Illinois	California, Texas, Illinois, Kentucky.
43	Barytes (crude)	Georgia, Missouri, Tennessee, South Carolina	Rank same as for quantity.
34	Bauxite	Arkansas, Georgia, Tennessee, Alabama	Do.
53	Bismuth	Not separable by States	Not separable by States.
33	Borates	California, Nevada	Rank same as for quantity.
30	Briquets, fuel	Wisconsin, Pennsylvania, Washington, Oregon	Wisconsin, Pennsylvania, Oregon, Washington.
69	Bromine	Michigan, West Virginia, Ohio	Rank same as for quantity.
60	Cadmium (metal and sulphide)	Not separable by States	Not separable by States.
50	Calcium-magnesium chloride (natural)	Michigan, West Virginia, Ohio, California	Michigan, West Virginia, California, Ohio.
6	Cement	Pennsylvania, Indiana, California, Michigan	Pennsylvania, California, Indiana, Michigan.
66	Chats	Missouri	Rank same as for quantity.
85	Chromite	Maryland, Oregon, California	Maryland, California, Oregon.
4	Clay products		Ohio, Pennsylvania, New Jersey, Illinois.
27	Clay, raw	Pennsylvania, Missouri, New Jersey, Georgia	New Jersey, Pennsylvania, Missouri, Georgia.
1	Coal:		
	Bituminous	Pennsylvania, West Virginia, Illinois, Kentucky	Rank same as for quantity.
	Pennsylvania anthracite	Pennsylvania	Do.
5	Coke	Pennsylvania, Ohio, Indiana, Alabama	Pennsylvania, Indiana, Ohio, Illinois.
89	Columbite	South Dakota	Rank same as for quantity.
9	Copper	Arizona, Montana, Utah, Michigan	Do.
45	Diatomaceous earth and tripoli	California, Illinois, Oklahoma, Oregon	California, Oklahoma, Illinois, Missouri.
78	Emery	Virginia, New York	Rank same as for quantity.
46	Feldspar (crude)	North Carolina, Maine, New Hampshire, New York	Do.
17	Ferroalloys	Pennsylvania, New York, Ohio, Maryland	Pennsylvania, New York, Maryland, Ohio.
80	Flint lining for tube mills	Minnesota	Rank same as for quantity.
37	Fluorspar	Illinois, Kentucky, Colorado, New Mexico	Do.
39	Fuller's earth	Florida, Georgia, Texas, Illinois	Do.
49	Garnet, abrasive	New York, New Hampshire, North Carolina	Do.
75	Gems and precious stones		Figures by States not available.
16	Gold	California, Colorado, South Dakota, Arizona	Rank same as for quantity.
65	Graphite		Alabama, Texas, Rhode Island, Michigan.
	Amorphous	Rhode Island, Michigan, Nevada	Rank same as for quantity.
	Crystalline	Texas, Alabama	Alabama, Texas.
42	Grindstones and pulpstones	Ohio, West Virginia, Michigan, Washington	Rank same as for quantity.
19	Gypsum	New York, Iowa, Michigan, Ohio	New York, Iowa, Ohio, Michigan.

[a] Rank of States in metal production (except aluminum, ferroalloys, and pig iron) arranged according to mine reports, not smelter output.

Mineral products of the United States and principal producing States in 1923—Continued

Rank in value	Product	Principal producing States	
		In order of quantity	In order of value
7	Iron ore	Minnesota, Michigan, Alabama, Pennsylvania	Minnesota, Michigan, Alabama, New York
3	Iron, pig	Pennsylvania, Ohio, Illinois, Indiana	Rank same as for quantity
13	Lead	Missouri, Idaho, Utah, Oklahoma	Do
18	Lime	Ohio, Pennsylvania, Missouri, West Virginia	Ohio, Pennsylvania, Massachusetts, Missouri.
77	Lithium minerals	South Dakota, New Mexico	Rank same as for quantity.
44	Magnesite (crude)	Washington, California	California, Washington.
67	Magnesium	New York, Michigan	Rank same as for quantity.
58	Magnesium chloride (natural)	Michigan, California	Do.
62	Magnesium sulphate (natural)	Michigan, Washington, California	Do.
47	Manganese ore	Montana, Arkansas, Colorado, Georgia	Montana, Arkansas, Virginia, Colorado
32	Manganiferous ore	Minnesota, Wisconsin, Michigan, Georgia	Rank same as for quantity.
56	Manganiferous zinc residuum	New Jersey	Do.
	Marl		
59	Calcareous	Virginia, California, West Virginia, South Carolina	California, Virginia, West Virginia, South Carolina.
72	Greensand	New Jersey	Rank same as for quantity.
55	Mica	North Carolina, New Hampshire, New Mexico, Virginia	Do.
	Scrap	do	Do.
	Sheet	North Carolina, New Hampshire, Virginia, New Mexico	North Carolina, New Hampshire, New Mexico, Virginia.
81	Millstones		New York, Maine, North Carolina, Minnesota
23	Mineral paints, zinc and lead pigments	Pennsylvania, Colorado, Illinois, Ohio	Pennsylvania, Illinois, Colorado, Ohio
28	Mineral waters	California, Wisconsin, New York, Ohio	Wisconsin, New York, California, Maine.
83	Molybdenum	New Mexico	Rank same as for quantity
8	Natural gas	West Virginia, Oklahoma, California, Pennsylvania	West Virginia, Pennsylvania, Oklahoma, Ohio.
12	Natural-gas gasoline	Oklahoma, Texas, California, West Virginia	Oklahoma, California, Texas, West Virginia.
74	Nickel	Not separable by States	Not separable by States.
61	Oilstones, etc	Indiana, Ohio, New Hampshire, Vermont	Arkansas, Indiana, Ohio, New Hampshire.
57	Peat	Illinois, New Jersey, California, Indiana	Rank same as for quantity.
79	Pebbles for grinding	California, Minnesota	Do.
2	Petroleum	California, Oklahoma, Texas, Wyoming	Oklahoma, California, Texas, Wyoming.
26	Phosphate rock	Florida, Tennessee, Idaho, Kentucky	Rank same as for quantity.
31	Platinum and allied metals	California, Oregon, Alaska, Wyoming	Do.
48	Potash (K_2O)	California, Nebraska, Pennsylvania, Indiana	Do.
63	Pumice	Kansas, Nebraska, California, Utah	Do.
51	Pyrites	California, Virginia, New York, Wisconsin	Do.
54	Quicksilver	California, Texas, Nevada, Oregon	Do.
21	Salt	Michigan, New York, Ohio, Kansas	Do.
11	Sand and gravel	Illinois, Indiana, New York, Ohio	Pennsylvania, Ohio, Illinois, New York.
38	Sand lime brick	Michigan, Wisconsin, Massachusetts, New York	Michigan, Massachusetts, New York, Wisconsin.
71	Selenium	Not separable by States	Not separable by States
64	Silica (quartz)	California, Wisconsin, Connecticut, New Hampshire	Wisconsin, Maryland, California, Connecticut.
52	Silica sand and sandstone (finely ground)	Illinois, New Jersey, Massachusetts	Rank same as for quantity.

15	Silver	Utah, Montana, Nevada, Idaho	Do.
25	Slate		Pennsylvania, Vermont, New York, Maine.
41	Sodium salts (other than NaCl) from natural sources.	California, Wyoming	Rank same as for quantity.
10	Stone	Pennsylvania, Ohio, Michigan, Illinois	Pennsylvania, Indiana, Ohio, New York.
22	Sulphur	Texas, Louisiana, Nevada, Utah	Rank same as for quantity.
29	Sulphuric acid from copper and zinc smelters	Tennessee, Illinois, Pennsylvania, West Virginia	Do.
35	Talc and soapstone	New York, Vermont, Virginia, California	New York, Virginia, Vermont, California.
87	Tellurium	Not separable by States	Not separable by States.
86	Tin	Alaska	Rank same as for quantity.
	Titanium ore:		
73	Ilmenite	Florida, Virginia	Do.
76	Rutile	Virginia	Do.
70	Tungsten ore	Colorado	Do.
68	Uranium and vanadium ores	Utah, Colorado	Do.
14	Zinc	Oklahoma, Kansas, New Jersey, Montana	Do.
82	Zircon	Florida	Do.

States and their principal mineral products in 1923 [a]

State	Rank	Percentage of total value for United States	Principal mineral products in order of value
Alabama	16	1.59	Coal, iron ore, cement, clay products.
Alaska	32	.39	Copper, gold, coal, silver.
Arizona	13	2.02	Copper, gold, silver, lead.
Arkansas	26	.81	Petroleum, coal, natural gas, bauxite.
California	4	7.33	Petroleum, cement, natural gas, clay products.
Colorado	21	1.18	Coal, gold, clay products, silver.
Connecticut	41	.14	Clay products, stone, lime, sand and gravel.
Delaware	50	.01	Clay products, stone, sand and gravel.
District of Columbia	49	.02	Sand and gravel, clay products, sand-lime brick, stone.
Florida	37	.24	Phosphate rock, stone, fuller's earth, sand and gravel.
Georgia	35	.27	Clay products, stone, cement, fuller's earth.
Idaho	28	.52	Lead, silver, zinc, gold.
Illinois	6	5.54	Coal, clay products, petroleum, cement.
Indiana	10	2.54	Coal, cement, stone, clay products.
Iowa	24	.89	Coal, cement, clay products, gypsum.
Kansas	12	2.10	Petroleum, zinc, coal, natural gas.
Kentucky	9	2.86	Coal, petroleum, clay products, natural gas.
Louisiana	22	1.18	Petroleum, sulphur, natural gas, natural-gas gasoline.
Maine	39	.15	Stone, lime, clay products, slate.
Maryland	31	.41	Coal, clay products, cement, sand and gravel.
Massachusetts	34	.28	Stone, clay products, lime, sand and gravel.
Michigan	11	2.47	Iron ore, copper, cement, salt.
Minnesota	8	3.35	Iron ore, stone, cement, clay products.
Mississippi	47	.04	Sand and gravel, clay products, mineral waters, stone.
Missouri	17	1.52	Lead, clay products, cement, coal.
Montana	19	1.44	Copper, silver, coal, zinc.
Nebraska	46	.06	Cement, clay products, sand and gravel, stone.
Nevada	27	.55	Copper, silver, gold, gypsum.
New Hampshire	43	.07	Stone, clay products, sand and gravel, feldspar.
New Jersey	20	1.40	Clay products, zinc, cement, sand and gravel.
New Mexico	29	.46	Coal, copper, zinc, silver.
New York	14	1.73	Clay products, cement, gypsum, stone.
North Carolina	38	.19	Stone, clay products, sand and gravel, feldspar.
North Dakota	45	.07	Coal, clay products, mineral waters, sand and gravel
Ohio	5	5.54	Clay products, coal, natural gas, petroleum.
Oklahoma	3	7.67	Petroleum, zinc, natural gas, natural-gas gasoline.
Oregon	42	.12	Cement, stone, sand and gravel, clay products.
Pennsylvania	1	23.60	Coal, cement, clay products, natural gas.
Rhode Island	48	.02	Stone, clay products, lime, sand and gravel.
South Carolina	44	.07	Stone, clay products, sand and gravel, barytes.
South Dakota	40	.14	Gold, stone, sand and gravel, gypsum.
Tennessee	25	.85	Coal, clay products, cement, stone.
Texas	7	5.08	Petroleum, sulphur, natural-gas gasoline, natural gas.
Utah	15	1.66	Copper, silver, lead, coal.
Vermont	36	.27	Stone, slate, lime, talc.
Virginia	23	.92	Coal, clay products, stone, cement.
Washington	30	.43	Coal, cement, clay products, sand and gravel.
West Virginia	2	7.95	Coal, natural gas, petroleum, clay products.
Wisconsin	33	.37	Stone, sand and gravel, mineral waters, iron ore.
Wyoming	18	1.49	Petroleum, coal, natural gas, natural-gas gasoline.

[a] In this table iron ore, not pig iron, is taken as the basis of iron valuation, and in the case of other metals mine production (recoverable content of metals) is the basis.

Prices of silver, copper, lead, and zinc, 1914–1923

Year	Silver [a]	Copper [b]	Lead [c]	Zinc [d]	Year	Silver [a]	Copper [b]	Lead [c]	Zinc [d]
	Per fine ounce	*Per pound*	*Per pound*	*Per pound*		*Per fine ounce*	*Per pound*	*Per pound*	*Per pound*
1914	$0.553	$0.133	$0.039	$0.051	1919	$1.12	$0.186	$0.053	$0.073
1915	.507	.175	.047	.124	1920	1.09	.184	.080	.081
1916	.658	.246	.069	.134	1921	1.00	.129	.045	.050
1917	.824	.273	.086	.102	1922	1.00	.135	.055	.057
1918	.98	.247	.071	.091	1923	.82	.147	.070	.068

[a] Average price furnished by Bureau of the Mint.
[b] For 1914–15, U. S. Geological Survey computation for electrolytic copper based on quotations by technical journals. For 1916 and later years, average price, all marketable grades.
[c] For 1914–15, New York price, U. S. Geological Survey computation from daily market spot quotations. For 1916, from outside spot quotations at New York. For 1917 and later years, average price.
[d] For 1914, St. Louis price, U. S. Geological Survey computation from daily market spot quotations. For 1915 and later years, average price, all grades.

DETAILED TABLES

ABRASIVE MATERIALS

PRODUCTION

Natural abrasives sold by the producers in the United States, 1921–1923

Abrasive	1921		1922		1923	
	Short tons	Value	Short tons	Value	Short tons	Value
Millstones	(a)	$24,524	(a)	$20,853	(a)	$22,229
Grindstones and pulpstones	26,340	1,227,322	26,524	1,020,186	46,570	1,689,315
Oilstones and scythestones	831	173,025	1,016	197,450	1,223	231,812
Emery	305	2,250	1,468	17,511	2,286	29,478
Garnet	3,048	260,687	7,054	566,879	9,006	688,437
Abrasive quartz and feldspar	(b)	(b)	(b)	(b)	(b)	(b)
Diatomaceous (infusorial) earth and tripoli [c]	67,474	895,629	74,966	703,397	92,915	1,082,163
Pumice	37,108	158,540	45,262	175,600	56,575	214,169
Grinding pebbles Tube-mill lining	989	14,637	3,159	30,798	4,551	51,795
		2,756,614		2,732,674		4,009,398

[a] Figures not available, as product is not reported by weight.
[b] See sections on feldspar and silica.
[c] Includes rottenstone and for 1921 an estimate for part of the diatomaceous earth.

IMPORTS AND EXPORTS

Value of abrasive materials imported for consumption in the United States, 1919–1923

Material	1919	1920	1921	1922	1923
Millstones and burrstones	$26,356	$20,954	$13,556	$15,356	$20,102
Grindstones and pulpstones	50,551	77,046	81,880	81,733	106,028
Hones, oilstones, and whetstones	12,199	56,416	35,761	48,938	53,233
Emery and corundum	595,208	617,187	393,454	389,390	722,688
Diatomaceous earth, tripoli, and rottenstone	12,545	16,323	13,203	10,429	11,779
Pumice	119,781	249,995	173,201	118,458	128,693
Diamond dust and bort	1,420,442	3,387,488	466,345	1,029,261	228,409
Garnet	(a)	(a)	(a)	[a] 1,837	93,803
	2,237,077	4,425,409	1,177,400	1,695,402	1,364,735

[a] Not separately classified prior to Sept. 22, 1922.

Value of domestic abrasive materials exported from the United States, 1919–1923

Material	1919	1920	1921	1922	1923
Grindstones	$297,068	$424,322	$281,976	$281,413	$499,123
Abrasive wheels, emery, and other	3,032,067	2,791,128	1,318,804	644,151	571,733
All other natural abrasives, hones, whetstones, etc	2,809,231	3,810,171	1,719,810	292,051	342,737
	6,138,366	7,025,621	3,320,590	1,217,615	1,413,593

ALUMINUM

[See Bauxite and aluminum]

ANTIMONY AND ANTIMONIAL LEAD

PRODUCTION

Mine production of antimony ores in the United States, 1915–1923, in short tons [a]

Year	Quantity	Antimony content
1915	5,000	2,100
1916	4,500	1,770
1917	1,060	390
1918	190	50
1922	20	4
1923	40	10

[a] Mine production negligible prior to 1915, and no production from 1919 to 1921.

Smelter production of metallic antimony in the United States, 1917–1918 [a]

Year	From domestic ores		From foreign ores		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1917	258	$106,812	2,182	$903,348	2,440	$1,010,160
1918	127	32,004	2,490	627,480	2,617	659,484

[a] Not recorded prior to 1917.

Only two smelters reported production (all from foreign ores) in 1919 and one in 1920, and the Survey is not at liberty to publish the figures. There was no production from 1921 to 1923.

Secondary antimony and antimony content of secondary alloys recovered from old alloys, scrap, and dross in the United States, 1918–1923

Year	Short tons	Value [a]	Year	Short tons	Value [a]
1918	5,226	$1,317,000	1921	4,720	$464,400
1919	4,399	717,900	1922	7,090	765,700
1920	5,600	938,560	1923	8,021	1,252,800

[a] Values calculated at average yearly price for ordinary brands of antimony as published by the American Metal Market.

By-product antimonial lead produced in the United States from both foreign and domestic ores, 1918–1923

Year	Short tons	Value	Antimony content (short tons)	Year	Short tons	Value	Antimony content (short tons)
1918	18,570	$2,826,350	2,566	1921	10,064	$870,059	1,589
1919	13,874	1,513,968	1,943	1922	8,075	844,993	1,441
1920	12,535	1,963,255	2,033	1923	14,190	1,950,370	2,170

IMPORTS AND EXPORTS

Antimony imported for consumption in the United States, 1919–1923

Year	Antimony ore [a]			Liquated antimony sulphide [b]		Metallic antimony [c]		Antimony oxides and other compounds [d]	
	Short tons	Antimony content		Short tons	Value	Short tons	Value	Short tons	Value
		Short tons	Value						
1919	993	409	$54,477	278	$19,202	7,159	$1,021,587	126	$9,501
1920	1,709	682	70,285	1,375	123,902	9,817	1,216,376	298	25,260
1921	213	98	11,682	353	17,577	10,130	784,146	154	15,558
1922				689	40,108	9,344	659,242	379	65,538
1923	(e)	1,047	44,721	835	64,493	6,763	641,804	2,277	288,206

[a] Classified in tariff classification as "Antimony ore and stibnite containing antimony."
[b] Classified in tariff classification as "Antimony matte, containing not more than 10 per cent of lead"; also as "needle or liquated antimony."
[c] Classified in tariff classification as "Antimony regulus or metal."
[d] Classified in tariff classification as "Antimony, oxide, salts, and compounds of."
[e] Figures not available.

Foreign antimony (matte, regulus, or metal) exported from the United States, 1918–1923

Year	Pounds	Value	Year	Pounds	Value
1918	1,410,970	$164,666	1921	299,776	$15,741
1919 [a]	429,059	33,913	1922 [b]	37,218	1,548
1920	896,034	51,607	1923	15,958	1,047

[a] Also 3 short tons of antimony ore, containing 5,380 pounds of antimony, valued at $1,665, was exported in 1919.
[b] During 1922 domestic exports of "matte, regulus, or metal" were 224,610 pounds, valued at $13,961. This is the first export of domestic antimony of which there is any record. However, foreign antimony manufactured in the United States and exported would be classed as domestic exports. Similar exports for 1923 are not shown.

PRICES

The average New York prices for the ordinary grades of metallic antimony are given by the American Metal Market as follows:

Average price (cents per pound) of metallic antimony at New York, 1918–1923

1918	12.55	1921	4.92
1919	8.16	1922	5.42
1920	8.38	1923	7.81

ARSENIC

PRODUCTION

White arsenic (refined and crude), produced in the United States, sold in 1918–1923

Year	Short tons	Value	Year	Short tons	Value
1918	[a] 6,323	$1,213,000	1921	4,786	$717,700
1919	[a] 6,029	1,181,684	1922	10,027	1,475,229
1920	11,502	2,021,356	1923	14,271	2,808,801

[a] In addition to the arsenious oxide (or white arsenic) elemental arsenic was produced from ore in 1918 and 1919. The totals shown include this elemental arsenic.

IMPORTS AND EXPORTS

Arsenic compounds imported for consumption in the United States, 1919–1923 [a]

Year	Arsenic or arsenious acid (white arsenic, As_2O_3)		Arsenic and sulphide of, or orpiment		Sheep dip		Paris green and London purple	
	Short tons	Value	Short tons	Value	Pounds	Value	Pounds	Value
1919	4,389	$624,494	2,151	$316,687	146,803	$12,346	18	$14
1920	3,740	532,635	4,080	684,016	70,168	5,150	772	277
1921	1,669	253,250	3,343	531,322	61,377	6,362	325	123
1922 [a]	1,081	162,494	3,815	472,044	70,390	4,877	3,866	741
1923 [a]	10,152	1,985,400	1,097	268,311	87,739	5,237	100,781	20,586

[a] Also 41,296 pounds of "acid," valued at $4,195, and 22,487 pounds of "metallic arsenic," valued at $3,484, imported Sept. 22 to Dec. 31, 1922. Not separately classified prior to new tariff. Corresponding imports for 1923 were 166,354 pounds of "acid," $15,597, and 174,415 pounds of "metallic arsenic," $37,314.

Foreign arsenic and sulphide of, or orpiment, exported from the United States, 1918–1923 [a]

Year	Pounds	Value	Year	Pounds	Value
1918	80,050	$12,017	1921	23,765	$2,835
1919			1922	14,290	1,555
1920	13,799	1,827	1923	[b]	[b]

[a] Domestic exports not separately recorded.
[b] Not separately recorded for 1923.

ASBESTOS

PRODUCTION

Domestic asbestos sold in the United States, 1919–1922, by varieties

Year	Chrysotile		Amphibole		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1919	502	$229,265	659	$19,000	1,161	$248,265
1920	1,245	661,907	403	16,324	1,648	678,231
1921	438	313,268	393	23,700	831	336,968
1922	25	3,320	42	6,800	67	10,120
1923	69	4,433	158	5,193	227	9,626

IMPORTS AND EXPORTS

Asbestos (unmanufactured) imported for consumption in the United States, 1918–1923 [a]

Year	Short tons	Value	Year	Short tons	Value
1918	137,700	$6,337,608	1921	72,463	$2,948,302
1919	135,270	7,369,685	1922	149,427	5,144,700
1920	167,558	9,120,253	1923	212,420	7,445,143

[a] Imports are mainly from Canada.

Asbestos (unmanufactured) exported from the United States, 1918–1923

Year	Short tons	Value	Year	Short tons	Value
1918	697	$51,053	1921	520	$101,600
1919	1,119	157,416	1922	376	49,939
1920	615	141,071	1923	680	48,525

ASPHALT AND RELATED BITUMENS

PRODUCTION

Native asphalt and related bitumens, produced in the United States, sold in 1918–1923

Year	Short tons	Value	Year	Short tons	Value
1918	60,034	$780,808	1921	296,412	$1,985,583
1919	88,281	682,989	1922	327,792	2,253,180
1920	198,497	1,213,908	1923	400,236	2,885,631

Asphalt, manufactured in the United States from petroleum, sold at refineries in 1919–1923

Year	From domestic petroleum		From Mexican petroleum	
	Short tons	Value	Short tons	Value
1919	614,692	$8,727,372	674,876	$7,711,510
1920	700,496	11,985,457	1,045,779	14,272,862
1921	624,220	9,048,221	908,093	11,761,358
1922	805,145	10,385,925	1,242,163	13,899,407
1923	995,654	13,060,174	1,378,722	16,840,045

IMPORTS AND EXPORTS

Asphalt and related bitumens imported for consumption in the United States, 1919–1923

Year	Crude asphalt		Ozokerite	
	Short tons	Value	Short tons	Value
1919	104,913	$609,923	1,874	$454,840
1920	127,027	1,055,951	2,136	499,758
1921	116,450	972,166	4,274	546,054
1922	120,359	940,873	4,495	371,161
1923	138,430	1,046,603	2,428	213,407

Year	Ichthyol		Bituminous limestone		Total	
	Pounds	Value	Short tons	Value	Short tons	Value
1919	30,976	$38,975	735	$5,576	107,537	$1,109,314
1920	98,135	79,133	1,387	11,665	130,599	1,646,507
1921	76,020	107,752	12,085	157,124	132,847	1,783,096
1922	74,330	89,150	4,300	59,590	129,191	1,460,774
1923	[a] 20	15	6,205	33,303	147,063	1,293,328

[a] As recorded by Bureau of Foreign and Domestic Commerce. Change in classification under new tariff may account to some extent for great decrease.

Asphalt exported from the United States, 1919–1923

Year	Unmanufactured		Manufactures of (value)	Total value
	Short tons	Value		
1919	40,208	$1,103,930	$606,918	$1,710,848
1920	51,706	1,356,116	842,074	2,198,190
1921	45,367	1,178,038	621,224	1,799,262
1922	57,362	1,344,440	[a] 1,261,125	2,605,565
1923	72,628	1,500,869	[a] 2,075,628	3,576,497

[a] Includes value of 588,636 squares (10x10 feet) of roofing asphalt ($870,200) in 1922 and 783,028 squares ($1,124,491) in 1923. Corresponding exports not separately shown prior to 1922.

BARYTES AND BARIUM PRODUCTS

BARYTES

PRODUCTION

Crude domestic barytes sold in the United States, 1918–1923

Year	Short tons	Value	Year	Short tons	Value
1918	155,368	$1,044,905	1921	66,369	$531,958
1919	209,330	1,727,822	1922	155,040	1,123,950
1920	228,113	2,142,464	1923	214,183	1,664,156

Crude domestic barytes sold in the United States, 1922 and 1923, by States

State	1922		1923	
	Short tons	Value	Short tons	Value
California	3,338	$17,707	[a]	[a]
Georgia	57,045	468,517	83,291	$670,343
Missouri	66,421	421,568	81,701	629,097
North Carolina	[a]	[a]	1,179	7,076
Tennessee	16,642	124,204	34,384	259,005
Other States [b]	11,594	91,954	13,628	98,635
	155,040	1,123,950	214,183	1,664,156

[a] Included under "Other States."
[b] 1922: Alabama, Idaho, Illinois, North Carolina, and South Carolina; 1923: Alabama, California, Kentucky, South Carolina, Virginia, and Wisconsin.

CONSUMPTION

Crude domestic and foreign barytes used in the manufacture of barium products in the United States, 1919–1923, in short tons

Year	In manufacture of—		
	Ground barytes	Lithopone	Barium chemicals
1919	64,922	103,688	32,976
1920	79,052	113,181	37,210
1921	28,296	61,359	10,952
1922	48,280	94,259	25,303
1923	47,713	128,547	34,327

IMPORTS

Crude barytes imported for consumption in the United States, 1918–1923

Year	Short tons	Value	Year	Short tons	Value
1918			1921	11,054	$59,371
1919	118	$594	1922	23,239	104,680
1920	24,874	146,858	1923	15,045	93,721

Exports of barytes are not separately reported.

BARIUM PRODUCTS

PRODUCTION

Barium products, manufactured in the United States from either domestic or imported crude ore, sold in 1919–1923, in short tons

Product	1919 [a]	1920	1921	1922	1923
Ground barytes	57,985	65,748	27,661	46,176	39,605
Lithopone	79,643	89,373	55,016	83,360	98,199
Barium chemicals [b]	20,013	20,760	5,487	13,901	16,803
	157,641	175,881	88,164	143,437	154,607

[a] Figures for 1919 represent production.
[b] In order to avoid duplication of figures, barium chemicals manufactured from other barium chemicals bought in open market are not included in table.

Barium chemicals, manufactured in the United States, sold in 1919–1923, in short tons

Chemical	1919	1920	1921	1922	1923
Barium carbonate	7,135	7,484	1,956	2,281	6,362
Barium chloride	4,509	3,084	(a)	2,022	3,301
Barium sulphate (blanc fixe)	5,227	8,046	2,471	7,349	6,761
Other barium chemicals [b]	3,142	2,146	1,060	2,249	379
	20,013	20,760	5,487	13,901	16,803

[a] Included under "Other barium chemicals."
[b] 1919: Binoxide, nitrate, and sulphide; 1920: Binoxide, hydroxide, nitrate, and sulphide; 1921: Chloride, hydroxide, and sulphide; 1922: Binoxide, hydroxide, sulphide, and sulphydrate; 1923: Hydroxide and sulphide.

IMPORTS AND EXPORTS

Barium products imported for consumption in the United States, 1919–1923

Product	1919	1920	1921	1922	1923	
					Short tons	Value
Manufactured barytes		$3,017	$16,942	$59,453	6,022	$88,741
Lithopone	$122,708	263,240	432,019	885,671	10,440	776,383
Barium carbonate:						
Natural (ground witherite)	4,739	61,284	25,188	39,114	1,557	41,823
Manufactured (chemically precipitated)	2,666	37,462	80,603	210,250	1,901	79,482
Barium binoxide		64,447	127,631	189,334	905	152,270
Barium chloride	19,846	151,778	72,621	112,785	1,278	75,014
Blanc fixe, or barium sulphate (chemically precipitated)	90	8,485	22,470	76,445	587	32,063
Barium hydroxide	(a)	(a)	(a)	[a] 6,573	181	16,872
Barium nitrate	(a)	(a)	(a)	[a] 16,795	511	59,766
	150,049	589,713	777,474	1,596,420	23,382	1,322,414

[a] Not separately classified prior to Sept. 22, 1922.

Prior to 1922 barium products had not been exported in appreciable quantity, and no separate record of the exports was kept. Exports of lithopone amounted in 1922 to 1,616 short tons, valued at $169,982, and in 1923 to 1,485 tons, valued at $176,624.

BAUXITE AND ALUMINUM

BAUXITE

PRODUCTION

Bauxite produced in the United States, 1919–1923

Year	Georgia, Alabama, and Tennessee		Arkansas		Total	
	Long tons	Value	Long tons	Value	Long tons	Value
1919	43,076	$346,588	333,490	$1,855,159	376,566	$2,201,747
1920	40,029	349,453	481,279	2,897,892	521,308	3,247,345
1921	14,700	134,400	124,850	755,400	139,550	889,800
1922	42,810	329,440	266,790	1,682,890	309,600	2,012,330
1923	28,810	176,030	493,880	2,980,580	522,690	3,156,610

IMPORTS AND EXPORTS

Bauxite imported for consumption in the United States, 1918–1923

Year	Long tons	Value	Year	Long tons	Value
1918	3,653	$14,791	1921	27,587	$164,589
1919	6,082	36,820	1922	23,656	93,805
1920	42,895	251,284	1923	119,020	593,882

Bauxite (including bauxite concentrates) exported from the United States, 1918–1923

Year	Long tons	Value	Year	Long tons	Value
1918	19,711	$1,523,688	1921	5,942	$488,785
1919	17,701	1,372,094	1922	19,617	961,208
1920	22,257	1,843,596	1923	78,560	3,380,486

ALUMINUM

PRODUCTION

Value of aluminum produced in the United States, 1918–1923

Year	Primary metal	Secondary metal [a]	Year	Primary metal	Secondary metal [a]
1918	$41,159,000	$10,113,600	1921	$10,906,000	$3,775,400
1919	38,558,000	12,014,600	1922	13,622,000	6,085,900
1920	41,375,000	9,489,100	1923	28,305,000	10,824,600

[a] Value of secondary aluminum based on average price at New York, as given by American Metal Market.

IMPORTS AND EXPORTS

Aluminum imported for consumption in the United States, 1919–1923

Year	Crude and semicrude [a]		Manufactures of [b]	Total value
	Pounds	Value		
1919	13,852,065	$4,530,579	$38,016	$4,568,595
1920	39,298,649	12,183,891	893,131	13,077,022
1921	32,559,017	7,627,508	1,262,283	8,889,791
1922	43,891,933	8,286,819	1,408,193	9,695,012
1923	42,476,789	8,316,816	425,747	8,742,563

[a] Includes crude aluminum, plates, sheets, wire, etc.
[b] Includes aluminum leaf, kitchen utensils, and all other manufactures of aluminum.

Aluminum and manufactures of aluminum exported from the United States, 1919–1923

Year	Crude and semicrude [a]		Manufactures of	Total value
	Pounds	Value		
1919	5,020,352	$1,744,896	$2,145,430	$3,890,326
1920	9,407,631	3,067,617	2,563,164	5,630,781
1921	2,196,378	801,075	2,307,782	3,108,857
1922	4,347,020	1,127,460	[b] 1,708,656	2,836,116
1923	5,539,671	1,517,562	[b] 2,053,977	3,571,539

[a] Includes ingots, metal and alloys, plates and sheets, etc.
[b] Represents value of 4,544,949 pounds in 1922 and 5,402,034 pounds in 1923 of tubes, moldings, castings, and other shapes, table, kitchen, or hospital utensils, and other manufactures. Figures of quantity not available prior to 1922.

PRICES

Average open-market price, small lots of aluminum, in the United States, 1918–1923, in cents per pound [a]

1918	33.42	1921	[b] 26.10
1919	32.38	1922	[b] 21.10
1920	33.07	1923	26.50

[a] Engineering and Mining Journal-Press quotations.
[b] Domestic aluminum; foreign grades 2 to 3 cents less.

BISMUTH

PRODUCTION

The bismuth produced in the United States is a by-product obtained in the refining of lead and tin bullion, part of which is from ores of foreign origin. The Survey is not at liberty to publish the figures of production.

IMPORTS

Bismuth imported for consumption in the United States, 1918–1923

Year	Pounds	Value	Year	Pounds	Value
1918	135,700	$277,273	1921	94,085	$114,891
1919	57,607	55,179	1922 [a]	121,505	239,777
1920	72,771	161,877	1923 [a]	62,640	146,178

[a] Also 9,392 pounds of "compounds, mixtures, and salts of bismuth," valued at $8,681, imported Sept. 22 to Dec. 31, 1922. Not separately classified prior to new tariff. Similar imports in 1923 were 11,731 pounds, valued at $13,717.

Exports of bismuth are not separately recorded.

BORAX

[See Sodium compounds]

BRIQUETS (FUEL)

Fuel briquets produced in the United States, 1918–1923

Year	Short tons	Value	Year	Short tons	Value
1918	477,235	$3,212,793	1921	398,949	$3,632,301
1919	295,734	2,301,054	1922	619,425	5,444,926
1920	567,192	4,623,831	1923	696,810	5,898,698

BROMINE

PRODUCTION

Bromine sold by the producers in the United States, 1918–1923

Year	Pounds	Value	Year	Pounds	Value
1918	1,727,156	$970,099	1921	711,953	$172,759
1919	1,854,971	1,234,969	1922	1,005,174	150,668
1920	1,160,584	745,381	1923	842,352	146,176

IMPORTS

Imports of bromine in 1923 were 782 pounds, valued at $1,171, compared with 1,094 pounds, valued at $339, in 1922 and 300 pounds, valued at $84, in 1921. None were recorded for 1920.

Exports are not specifically shown.

CADMIUM

PRODUCTION

Metallic cadmium and cadmium sulphide produced in the United States, 1919–1923

Year	Metallic cadmium		Cadmium sulphide	
	Pounds	Value	Pounds	Value
1919	99,939	$121,926	31,197	$37,436
1920	129,283	151,261	32,133	37,274
1921	68,501	67,131	65,446	71,336
1922	131,590	143,433	134,774	152,295
1923	183,816	161,758	[a]	[a]

[a] Survey not at liberty to publish figures.

IMPORTS

Imports of cadmium in 1923 for consumption were 16 pounds, valued at $119, compared with 2,240 pounds, valued at $2,434, in 1922 and 101 pounds, valued at $216, in 1921. No cadmium was imported from 1916 to 1920, inclusive.

Exports of cadmium are not separately recorded.

CALCIUM CHLORIDE

PRODUCTION

Calcium-magnesium chloride, from natural brines, sold by the producers in the United States, 1918–1923

Year	Short tons	Value	Year	Short tons	Value
1918	26,624	$503,452	1921	23,672	$510,723
1919	26,123	321,596	1922	33,067	571,326
1920	27,849	539,471	1923	44,961	663,384

IMPORTS

Imports of calcium chloride in 1923 amounted to 3,232 short tons, valued at $48,527. From Sept. 22 to Dec. 31, 1922, 740 tons, valued at $8,563, was imported. Similar imports were not separately recorded prior to new tariff.

Exports of calcium chloride are not separately shown.

CARBON BLACK

Carbon black produced from natural gas in the United States, 1919–1923

Year	Number of producers reporting	Carbon black produced		Natural gas used (estimate)
		Pounds	Value	M cubic feet
1919	17	52,056,941	$3,816,040	49,896,000
1920	19	51,321,892	4,032,286	40,599,000
1921	23	59,766,315	5,445,878	50,565,000
1922	26	67,795,129	5,819,618	53,629,000
1923	47	138,262,648	11,692,066	109,096,000

CEMENT

PRODUCTION

Hydraulic cements shipped from mills in the United States, 1919–1923

Year	Masonry, natural, and puzzolan cements		Portland cement		Total	
	Barrels	Value	Barrels	Value	Barrels	Value
1919	528,589	$583,554	85,612,899	$146,734,844	86,141,488	$147,318,398
1920	767,481	1,150,890	96,311,719	194,439,025	97,079,200	195,589,915
1921	539,402	897,025	95,507,147	180,778,415	96,046,549	181,675,440
1922	889,428	1,293,598	117,701,216	207,170,430	118,590,644	208,464,028
1923	1,271,674	1,947,352	135,912,118	257,684,424	137,183,792	259,631,776

Portland cement produced in the United States, 1918–1923, in barrels

1918	71,081,663	1921	98,842,049
1919	80,777,935	1922	114,789,984
1920	100,023,245	1923	137,460,238

Portland cement produced, shipped, and in stock in the United States, 1922 and 1923, by States

State	Production				Shipments				Stock (Dec. 31) (barrels)	
	Active plants		Barrels		1922		1923		1922	1923
	1922	1923	1922	1923	Barrels	Value	Barrels	Value		
Alabama	3	5	2,290,884	3,497,256	2,324,116	$4,135,684	3,395,392	$6,257,673	34,901	136,765
California	9	9	8,711,515	11,001,910	9,041,788	20,478,577	10,882,802	26,022,156	292,486	411,594
Illinois	4	4	6,407,129	7,147,906	6,554,945	10,584,171	7,129,208	12,550,100	643,244	661,942
Iowa	4	5	4,272,432	5,732,470	4,475,074	7,709,313	5,570,675	10,351,971	790,447	952,242
Kansas	7	7	4,634,287	6,025,657	4,556,517	8,138,268	5,878,839	10,868,590	621,927	768,745
Michigan	12	14	6,243,805	7,619,792	6,349,751	11,145,573	7,466,283	14,038,322	630,383	783,892
Missouri	5	5	6,170,633	7,305,997	6,239,144	10,457,557	7,143,883	13,237,141	636,625	798,739
New York	9	9	5,922,706	6,990,174	6,194,663	10,694,426	6,853,062	12,834,471	516,151	653,263
Ohio	5	6	2,835,243	4,188,755	2,913,034	5,243,687	4,003,321	7,615,741	161,797	347,231
Pennsylvania	22	22	33,276,093	38,157,482	34,023,695	55,528,002	38,610,852	69,792,343	2,574,229	2,120,859
Texas	5	5	3,628,756	4,178,895	3,730,477	7,515,932	4,091,284	8,011,226	190,762	278,373
Washington	4	4	1,942,781	2,105,711	1,951,414	4,684,624	2,111,479	4,988,022	246,660	240,892
Other States [a]	29	31	28,453,720	33,508,233	29,346,598	50,854,616	32,775,038	61,116,668	2,012,638	2,745,833
	118	126	114,789,984	137,460,238	117,701,216	207,170,430	135,912,118	257,684,424	9,352,250	10,900,370

[a] Colorado, Georgia, Indiana, Kentucky, Maryland, Minnesota, Montana, Nebraska, New Jersey, Oklahoma, Oregon, Tennessee, Utah, Virginia, and West Virginia.

Portland cement produced, shipped, and in stock in the United States, 1922, and 1923, by districts

Commercial district	Production				Shipments				Stock (Dec. 31) (barrels)	
	Active plants		Barrels		1922		1923		1922	1923
	1922	1923	1922	1923	Barrels	Value	Barrels	Value		
Eastern Pennsylvania, New Jersey, and Maryland	22	22	31, 195, 617	35, 721, 751	31, 897, 649	$51, 953, 144	36, 133, 963	$65, 536, 543	2, 295, 324	1, 883, 112
New York	9	9	5, 922, 706	6, 990, 174	6, 194, 663	10, 694, 426	6, 853, 062	12, 834, 471	516, 151	653, 263
Ohio, western Pennsylvania, and West Virginia	10	11	10, 753, 301	13, 495, 799	11, 040, 908	18, 586, 754	13, 211, 380	24, 183, 471	776, 261	1, 060, 680
Michigan	12	14	6, 243, 805	7, 619, 792	6, 349, 751	11, 145, 573	7, 466, 283	14, 038, 322	630, 383	783, 892
Illinois, Indiana, and Kentucky	10	10	17, 998, 914	21, 193, 666	18, 676, 656	30, 159, 728	21, 056, 914	37, 010, 579	1, 434, 407	1, 571, 159
Virginia, Tennessee, Alabama, and Georgia	8	11	5, 954, 043	7, 908, 846	6, 158, 652	10, 854, 347	7, 620, 850	14, 210, 617	169, 597	457, 593
Eastern Missouri, Iowa, and Minnesota	9	10	11, 392, 552	14, 037, 099	11, 657, 484	19, 528, 016	13, 624, 173	25, 022, 674	1, 516, 568	1, 929, 494
Western Missouri, Nebraska, Kansas, and Oklahoma	11	11	8, 025, 720	9, 779, 034	7, 967, 266	14, 570, 823	9, 573, 003	18, 185, 384	956, 887	1, 162, 918
Texas	5	5	3, 628, 756	4, 178, 895	3, 730, 477	7, 515, 932	4, 091, 284	8, 011, 226	190, 762	278, 373
Colorado and Utah	5	5	2, 020, 784	2, 427, 971	2, 063, 500	4, 609, 605	2, 340, 386	5, 163, 340	202, 608	290, 193
California	9	9	8, 711, 515	11, 001, 910	9, 041, 788	20, 478, 577	10, 882, 802	26, 022, 156	292, 486	411, 594
Oregon, Washington, and Montana	8	9	2, 942, 271	3, 105, 301	2, 922, 422	7, 073, 505	3, 058, 018	7, 465, 641	370, 816	418, 099
	118	126	114, 789, 984	137, 460, 238	117, 701, 216	207, 170, 430	135, 912, 118	257, 684, 424	9, 352, 250	10, 900, 370

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IMPORTS AND EXPORTS

Cement imported for consumption in the United States, 1918–1923

Year	Barrels	Value	Year	Barrels	Value
1918	305	$1,200	1921	122,317	$388,842
1919	8,931	52,636	1922	355,931	692,429
1920	524,604	1,254,729	1923	1,767,264	3,145,977

Cement exported from the United States, 1918–1923

Year	Barrels	Value	Year	Barrels	Value
1918	2,252,446	$5,912,166	1921	1,181,014	$4,276,986
1919	2,463,573	7,513,389	1922	1,127,845	3,206,201
1920	2,985,807	10,045,369	1923	1,001,688	2,944,174

CHROMITE

PRODUCTION

Chromite shipped from mines in the United States, 1918–1923

Year	Long tons	Value	Year	Long tons	Value
1918	82,430	$3,955,567	1921	282	$2,900
1919	5,079	129,302	1922	355	7,288
1920	2,502	44,857	1923	227	3,819

Crude chromite produced by different countries, 1919–1923, in metric tons

Country	1919	1920	1921	1922	1923
Australia [a]	254	1,643	63	537	1,211
Brazil [b]	4,877	3,506			
Canada [c]	7,748	9,993	2,538	696	2,654
Cuba [b]	14,693	721	610		10,587
Great Britain [d]	152	1,118		605	(e)
Greece [f]	4,070	12,492	5,919	9,927	13,350
Guatemala [b]	1,686	1,140	401		
India [g]	37,024	27,231	35,320	23,143	(e)
Japan [h]	6,012	3,969	3,368	3,757	(e)
New Caledonia [i]	23,548	91,534	29,458	19,374	23,226
Norway [j]	460				(e)
Rhodesia [k]	32,007	54,674	45,529	84,799	87,702
Russia [l]	(e)	2,965	4,013	308	(e)
Turkey (Asia Minor) [m]	(e)	25,000	(e)	2,540	
Union of South Africa [n]			1,078	87	
United States	5,161	2,542	287	361	231
Yugoslavia [o]		10	10	15	(e)
	137,692	238,538	128,594	146,149	(e)

[a] 1919–1922: New South Wales, Dept. Mines Ann. Repts. Queensland, Undersecretary for Mines Ann. Repts. 1923: Sec. Mines, New South Wales.
[b] Imports into United States, Bur. Foreign and Domestic Commerce.
[c] 1919–1920: Canada Dept. Mines, Mines Branch, Ann. Repts. 1921–1923: Dominion Bur. Statistics.
[d] 1919–1920: Mines and Quarries, General Repts., pt. 3. 1921–1922: Sec. Mines and H. M. Chief Inspector for Mines Dept. Ann. Rept.
[e] Figures not yet available.
[f] 1919–1920: Tableaux statistiques du mouvement minier de la Grèce. 1921–1923: Information furnished by Direction du Service des mines, Athens, Greece.
[g] India Geol. Survey Records.
[h] 1919: Japan Dept. Commerce Bur. Mines. 1920–1921: Information from United States consulate, Yokohama, Japan. 1922: Oil, Paint, and Drug Reporter, July 9, 1923.
[i] 1919–1922: Bulletin de l'Agence des colonies. (Figures represent exports). 1923: L'Echo des mines.
[j] Norges Bergverksdrift.
[k] Rhodesia, Sec. Mines Repts.
[l] 1920: Mining Jour., London. 1921: U. S. Dept. Commerce, Commerce Repts., June 26, 1922. 1922: Gorny i Zhurnal, Nos. 3 and 4, 1923.
[m] 1920: Estimate based largely on information furnished by E. J. Lavino & Co., importers. 1922–1923: Estimate.
[n] Dept. Mines and Industries Ann. Repts.
[o] 1919: Wray, D. A., Report of geologist attached to the British Economic Mission to Serbia, 1921. 1920–1922: Royal Ministry of Forests and Mines (1920, exports; 1921–1922, production).

IMPORTS

Crude chromite imported into the United States, 1919–1923, by countries, in long tons

Country	1919	1920	1921	1922	1923
Australia	13,161	2,778		4,000	
Belgium		239			
Brazil	4,800	3,451			
British South Africa	29	39,400	23,318	41,002	52,153
Canada	8,941	8,491	7,554	801	3,401
Cuba	14,461	710	600	1	10,420
England		3,799		1,900	[a]
French Oceania	7,125	56,682	35,108	7,500	7,410
Germany		1			
Greece		5,302	8,104	8,600	10,550
Guatemala	1,659	1,122	401		
India, British		4,500	928	12,677	29,238
New Zealand	693				
Portuguese Africa	4,000	11,000		11,100	15,591
Spain	3,035	40			
Turkey in Asia	3,500	12,760	5,822	[b] 2,500	
Turkey in Europe			1		
Total value	61,404 $1,381,497	150,275 $1,921,824	81,836 $654,602	90,081 $741,186	128,763 $1,123,120

[a] Small quantity; weight not recorded.
[b] Listed by Bureau of Foreign and Domestic Commerce as Greece in Asia.

There are no exports of chromite.

CLAY

PRODUCTION

Domestic clay sold in the United States, 1919–1923

Year	Kaolin, china clay, and paper clay		Ball clay		Slip clay		Fire clay	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1919	152,828	$1,475,681	65,026	$520,849	5,149	$17,556	1,755,331	$4,628,605
1920	268,203	2,865,407	69,477	584,611	9,006	41,519	2,261,915	7,088,049
1921	162,726	1,579,163	54,014	354,565	4,608	14,841	1,195,861	3,560,373
1922	275,675	2,346,095	76,792	440,877	4,050	19,405	1,679,220	4,633,486
1923	336,803	2,926,255	97,068	620,978	8,520	43,609	2,298,163	6,565,899

Year	Stoneware clay		Miscellaneous clay		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1919	60,236	$80,367	236,530	$367,573	2,275,100	$7,090,631
1920	106,350	229,221	322,100	467,856	3,037,051	11,276,663
1921	86,574	184,540	242,963	361,818	1,746,746	6,055,300
1922	86,866	164,870	525,097	725,781	2,647,700	8,330,514
1923	81,389	194,358	612,717	837,814	3,434,660	11,188,913

IMPORTS AND EXPORTS

Clay imported for consumption in the United States, 1919–1923

Year	Kaolin or china clay		Common blue and Gross-Almerode glass-pot clay		All other clays				Total	
					Unwrought		Wrought			
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1919	180, 592	$1, 965, 393	4	$133	23, 759	$187, 550	498	$4, 262	204, 853	$2, 157, 338
1920	361, 800	3, 568, 677	6, 837	157, 201	34, 252	272, 524	691	10, 267	403, 580	4, 008, 669
1921	162, 906	1, 546, 285	4, 468	77, 217	41, 421	348, 870	120	2, 313	208, 915	1, 974, 685
1922	310, 136	2, 963, 420	7, 323	84, 415	40, 624	327, 388	2, 566	29, 398	360, 649	3, 404, 621
1923	311, 298	3, 046, 191	12, 999	121, 272	65, 379	481, 614	1, 676	21, 892	391, 352	3, 670, 969

Domestic clay exported from the United States, 1919–1923

Year	Fire clay		All other		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1919	37, 486	$262, 501	30, 983	$249, 571	68, 469	$512, 072
1920	54, 125	393, 177	66, 035	775, 222	120, 160	1, 168, 399
1921	23, 666	177, 979	23, 779	183, 449	47, 445	361, 428
1922	24, 391	169, 664	[a] 23, 285	[a] 267, 908	47, 676	437, 572
1923	50, 055	303, 675	34, 840	329, 192	84, 895	632, 867

[a] Includes 2,091 short tons of "kaolin, china clay, and paper clay," valued at $27,840. Similar exports not shown separately for other years.

CLAY PRODUCTS

PRODUCTION

Clay products of the United States, 1922 and 1923, by products [a]

Product	1922		1923	
	Quantity	Value	Quantity	Value
Common brick, thousands	5, 898, 898	$72, 612, 999	7, 282, 181	$94, 472, 666
Vitrified brick or block, do	517, 287	10, 815, 574	699, 269	15, 569, 670
Face brick, do	1, 416, 878	28, 233, 689	1, 931, 175	38, 891, 834
Fancy or ornamental brick, do	6, 796	160, 469	12, 879	252, 323
Enameled brick, do	15, 380	1, 296, 651	19, 502	1, 670, 852
Architectural terra cotta, short tons	107, 224	12, 409, 543	138, 462	16, 486, 039
Fireproofing and hollow building tile, do	2, 870, 308	19, 707, 614	3, 764, 744	28, 274, 801
Tile (not drain)		16, 596, 737		23, 804, 157
Draintile, short tons	594, 843	5, 148, 987	615, 640	5, 099, 955
Sewer pipe, do	1, 422, 162	23, 599, 649	1, 777, 584	29, 102, 511
Stove lining, do	(b)	1, 224, 068	54, 684	1, 218, 970
Fire brick, thousands	836, 724	31, 356, 741	1, 134, 223	46, 676, 637
Miscellaneous		6, 345, 385		8, 111, 146
Total brick and tile		229, 508, 106		309, 631, 561
Total pottery		91, 986, 297		114, 951, 067
Grand total		321, 494, 403		424, 582, 628

[a] Canvass discontinued by Geological Survey after 1920. Figures obtained through cooperation with Bureau of the Census.

[b] Figures for quantity not available.

Value of clay products of the United States, 1922 and 1923, by States [a]

State	1922				1923			
	Number of firms reporting	Brick and tile	Pottery	Total	Number of firms reporting	Brick and tile	Pottery	Total
Alabama	39	$2,772,155	$26,100	$2,798,255	45	$3,914,677	$6,890	$3,921,567
Arizona	6	123,780	----------	123,780	7	102,337	----------	102,337
Arkansas	15	976,111	(b)	b 976,111	17	1,202,857	(b)	b 1,202,857
California	62	12,680,942	2,008,888	14,689,830	86	17,016,093	3,816,960	20,833,053
Colorado	36	3,142,537	288,660	3,431,197	43	4,036,594	377,008	4,413,602
Connecticut and Rhode Island	24	2,675,150	(b)	b 2,675,150	31	3,892,992	(b)	b 3,892,992
Delaware	10	219,633	----------	219,633	11	249,804	----------	249,804
District of Columbia	4	235,453	(b)	b 235,453	4	242,980	(b)	b 242,980
Florida	11	174,578	(b)	b 174,578	11	214,157	(b)	b 214,157
Georgia	35	4,141,688	15,913	4,157,601	40	5,731,268	7,860	5,739,128
Idaho	6	128,259	----------	128,259	5	135,920	----------	135,920
Illinois	119	23,041,251	3,743,012	26,784,263	147	29,527,311	4,691,676	34,218,987
Indiana	107	10,451,027	3,491,112	13,942,139	110	12,747,678	2,895,450	15,643,128
Iowa	69	5,739,449	(b)	b 5,739,449	77	6,920,336	(b)	b 6,920,336
Kansas	28	3,715,819	----------	3,715,819	29	4,425,067	----------	4,425,067
Kentucky	39	4,986,502	(b)	b 4,986,502	44	7,409,056	201,123	7,610,179
Louisiana	14	578,615	(b)	b 578,615	20	731,252	(b)	b 731,252
Maine	14	768,725	----------	768,725	17	877,555	----------	877,555
Maryland	27	2,645,271	950,733	3,596,004	33	3,016,790	1,892,708	4,909,498
Massachusetts	33	1,984,067	518,547	2,502,614	45	3,002,341	1,192,514	4,194,855
Michigan	34	2,306,868	1,989,345	4,296,213	44	4,224,634	2,734,644	6,959,278
Minnesota	25	2,201,502	(b)	b 2,201,502	27	2,031,408	(b)	b 2,031,408
Mississippi	21	645,721	46,058	691,779	23	878,684	(b)	b 878,684
Missouri	59	11,649,495	96,513	11,746,008	66	17,802,813	100,961	17,903,774
Montana	10	290,781	----------	290,781	12	312,219	----------	312,219
Nebraska	20	857,185	(b)	b 857,185	23	939,138	(b)	b 939,138
Nevada	1	(c)	----------	(c)	1	(c)	----------	(c)
New Hampshire	12	603,322	----------	603,322	12	913,389	(b)	b 913,389
New Jersey	116	17,243,445	20,881,443	38,124,888	134	21,182,130	23,739,584	44,921,714
New Mexico	3	(c)	----------	(c)	3	133,118	----------	133,118
New York	105	14,862,925	5,685,884	20,548,809	124	18,872,794	6,353,393	25,226,187
North Carolina	69	2,999,822	12,488	3,012,310	73	3,656,452	(b)	b 3,656,452
North Dakota	3	173,715	----------	173,715	3	181,933	----------	181,933
Ohio	353	38,128,927	33,218,387	71,347,314	397	56,070,190	43,008,797	99,078,987
Oklahoma	19	1,935,570	----------	1,935,570	20	1,870,436	----------	1,870,436
Oregon	13	569,289	(b)	b 569,289	14	612,785	(b)	b 612,785
Pennsylvania	275	35,760,030	5,923,014	41,683,044	326	50,667,046	7,862,435	58,529,481
South Carolina	18	884,513	(b)	b 884,513	25	1,448,790	(b)	b 1,448,790
South Dakota	2	(c)	----------	(c)	2	(c)	----------	(c)
Tennessee	31	2,774,727	1,503,543	4,278,270	45	4,244,092	635,756	4,879,848
Texas	55	4,284,861	91,540	4,376,401	58	5,429,127	143,538	5,572,665
Utah	12	860,433	(b)	b 860,433	13	930,831	5,870	936,701
Vermont	1	(c)	----------	(c)	1	(c)	----------	(c)
Virginia	36	2,845,510	(b)	b 2,845,510	47	3,879,102	439,650	4,318,752
Washington	28	1,939,720	43,039	1,982,759	32	2,265,706	30,536	2,296,242
West Virginia	44	3,158,123	9,821,258	12,979,381	53	4,336,501	13,237,595	17,574,096
Wisconsin	32	926,536	(b)	b 926,536	36	1,058,138	(b)	b 1,058,138
Wyoming	3	(c)	----------	(c)	5	136,493	----------	136,493
Undistributed	------	424,074	1,630,820	2,054,894	------	156,547	1,576,119	1,732,666
	2,098	229,508,106	91,986,297	321,494,403	2,441	309,631,561	114,951,067	424,582,628

[a] Figures obtained through cooperation with Bureau of the Census.
[b] Pottery included under "Undistributed."
[c] Included under "Undistributed."

IMPORTS AND EXPORTS

Value of clay products imported for consumption in the United States, 1919–1923

Year	Pottery								Brick, fire brick, tile, and miscellaneous clay products	Grand total
	Brown earthen and common stone ware [a]	Tobacco pipes and pipe bowls of clay	Earthenware and crockery composed of non-vitrified absorbent body		China and porcelain		Sanitary earthenware decorated and not decorated	Total		
			Not decorated	Decorated	Not decorated	Decorated				
1919	$293,120	$15,852	$350,644	$2,476,210	$359,560	$3,726,695	$7,980	$7,230,061	$196,839	$7,426,900
1920	390,962	12,091	340,676	3,805,955	431,636	5,856,384	13,068	10,850,772	252,656	11,103,428
1921	288,893	11,535	405,370	3,871,554	646,427	6,918,179	12,067	12,154,025	228,804	12,382,829
1922	341,997	15,638	339,066	4,427,001	641,261	6,298,440	17,295	12,080,698	375,764	12,456,462
1923	263,388	26,606	881,480	4,916,903	864,239	8,830,266	346,589	16,129,474	864,124	16,993,598

[a] Including Rockingham ware and miscellaneous pottery products.

Value of clay products of domestic manufacture exported from the United States, 1919–1923

Year	Building brick	Fire brick	Tile (except drain)	Earthen and stone ware	China	Sanitary earthenware	All other	Total
1919	$248,690	$2,747,512	$628,836	$1,148,051	$523,861	$563,734	$721,600	$6,582,284
1920	382,814	4,200,266	1,025,083	1,241,938	816,817	778,714	951,991	9,397,623
1921	415,402	2,314,911	814,456	1,014,329	312,161	535,506	873,182	6,279,947
1922	210,215	1,581,679	390,408	981,082	316,973	561,536	[a]1,599,949	5,641,842
1923	282,454	2,332,536	373,866	932,779	334,146	657,859	[a]1,915,842	6,829,482

[a] Includes electric porcelain valued at $1,379,750 in 1922 and $1,783,614 in 1923; not separately classified prior to 1922.

COAL

PRODUCTION

Coal produced in the United States, 1919–1923

Year	Pennsylvania anthracite		Bituminous		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1919	88,092,201	$364,926,950	465,860,058	$1,160,616,013	553,952,259	$1,525,542,963
1920	89,598,249	434,252,198	568,666,683	2,129,933,000	658,264,932	2,564,185,000
1921	90,473,451	452,304,903	415,921,950	1,199,983,600	506,395,401	1,652,288,600
1922	54,683,022	273,700,125	422,268,099	1,274,820,000	476,951,121	1,548,520,000
1923	93,339,009	506,786,768	564,564,662	1,514,621,000	657,903,671	2,021,408,000

Coal produced in the United States, 1922 and 1923, by States

[Including wagon mines]

State	1922		1923	
	Short tons	Value	Short tons	Value
Alabama	18, 324, 740	$42, 856, 000	20, 457, 649	$51, 624, 000
Alaska	79, 275	431, 000	119, 826	755, 000
Arkansas	1, 110, 046	4, 592, 000	1, 296, 892	5, 192, 000
California, Idaho, and Oregon	26, 893	104, 000	20, 066	79, 000
Colorado	10, 019, 597	31, 701, 000	10, 346, 218	33, 299, 000
Georgia	60, 636	246, 000	75, 620	327, 000
Illinois	58, 467, 736	168, 925, 000	79, 310, 075	198, 388, 000
Indiana	19, 132, 889	54, 524, 000	26, 229, 099	65, 046, 000
Iowa	4, 335, 161	16, 119, 000	5, 710, 735	20, 517, 000
Kansas	2, 955, 170	10, 816, 000	4, 443, 149	14, 275, 000
Kentucky	42, 134, 175	127, 037, 000	44, 777, 317	113, 542, 000
Maryland	1, 222, 707	4, 122, 000	2, 285, 926	6, 911, 000
Michigan	929, 390	4, 693, 000	1, 172, 075	5, 545, 000
Missouri	2, 924, 750	11, 153, 000	3, 403, 151	11, 575, 000
Montana	2, 572, 221	8, 208, 500	3, 147, 678	9, 652, 000
New Mexico	3, 147, 173	10, 977, 000	2, 915, 173	10, 668, 000
North Carolina	78, 570	388, 000	36, 019	132, 000
North Dakota	1, 327, 564	3, 513, 000	1, 385, 400	3, 275, 000
Ohio	26, 953, 791	87, 056, 000	40, 546, 443	98, 610, 000
Oklahoma	2, 802, 511	11, 527, 000	2, 885, 038	10, 874, 000
Pennsylvania (bituminous)	113, 148, 308	351, 777, 000	171, 879, 913	472, 217, 000
South Dakota	7, 752	22, 000	10, 379	25, 000
Tennessee	4, 876, 774	14, 096, 000	6, 040, 268	16, 515, 000
Texas	1, 106, 007	2, 563, 000	1, 187, 329	2, 162, 000
Utah	4, 992, 008	15, 687, 500	4, 720, 217	13, 657, 000
Virginia	10, 491, 174	27, 083, 000	11, 761, 643	32, 468, 000
Washington	2, 581, 165	10, 279, 000	2, 926, 392	10, 894, 000
West Virginia	80, 488, 192	236, 162, 000	107, 899, 941	285, 481, 000
Wyoming	5, 971, 724	18, 162, 000	7, 575, 031	20, 916, 000
Total bituminous	422, 268, 099	1, 274, 820, 000	564, 564, 662	1, 514, 621, 000
Pennsylvania anthracite	54, 683, 022	273, 700, 125	93, 339, 009	506, 786, 768
Grand total	476, 951, 121	1, 548, 520, 000	657, 903, 671	2, 021, 408, 000

Coal produced in the United States, 1922 and 1923, by months, in short tons

Month	Pennsylvania anthracite		Bituminous	
	1922	1923	1922	1923
January	6, 566, 000	8, 521, 000	38, 930, 000	51, 944, 000
February	7, 096, 000	7, 602, 000	42, 425, 000	43, 645, 000
March	9, 181, 000	9, 175, 000	51, 936, 000	48, 446, 000
April	27, 000	7, 885, 000	16, 335, 000	44, 057, 000
May	36, 000	8, 384, 000	21, 005, 000	47, 690, 000
June	86, 000	8, 474, 000	23, 096, 000	47, 083, 000
July	118, 000	8, 136, 000	17, 602, 000	46, 707, 000
August	164, 000	8, 672, 000	26, 755, 000	50, 578, 000
September	5, 075, 000	2, 853, 000	42, 463, 000	47, 841, 000
October	8, 896, 000	8, 532, 000	46, 733, 000	50, 907, 000
November	8, 695, 000	7, 575, 000	46, 900, 000	44, 425, 000
December	8, 743, 000	7, 530, 000	48, 088, 000	41, 242, 000
	54, 683, 000	93, 339, 000	422, 268, 000	564, 565, 000

Coal produced in the United States in 1923, by States

[Inclusive of product but not employees of wagon mines]

State	Loaded at mines for shipment (short tons)	Sold to local trade and used by employees (short tons)	Used at mines for steam and heat (short tons)	Made into coke at mines (short tons)	Total production			Number of employees				Average number of days worked
					Short tons	Value	Average value	Underground		Surface	Total	
								Miners, loaders, and shot-firers	All others			
Alabama	19,520,634	370,754	307,356	258,905	20,457,649	$51,624,000	$2.52	17,304	7,330	5,401	30,035	232
Alaska	104,867	12,734	2,225		119,826	755,000	6.30	73	48	78	199	220
Arkansas	1,245,350	12,845	38,697		1,296,892	5,192,000	4.01	2,124	846	784	3,754	97
California, Idaho, and Oregon	11,256	1,555	7,255		20,066	79,600	3.94	43	26	24	93	206
Colorado	9,390,124	534,464	231,595	190,035	10,346,218	33,299,000	3.22	8,064	3,114	2,162	13,340	174
Georgia	48,172	733	2,554	24,161	75,620	327,000	4.32	69	23	75	167	231
Illinois	73,842,388	3,606,769	1,860,918		79,310,075	198,388,000	2.50	64,194	24,900	10,620	99,714	158
Indiana	24,951,649	697,832	579,618		26,229,099	65,046,000	2.48	22,777	8,228	4,403	35,408	136
Iowa	5,027,502	556,180	127,053		5,710,735	20,517,000	3.59	7,797	2,709	942	11,448	181
Kansas	4,092,792	268,082	82,275		4,443,149	14,275,000	3.21	6,966	1,662	1,133	9,761	139
Kentucky	43,149,962	844,094	552,943	230,318	44,777,317	113,542,000	2.54	33,911	16,546	10,354	60,811	152
Maryland	2,181,688	77,823	26,415		2,285,926	6,911,000	3.02	2,360	814	551	3,725	178
Michigan	1,086,198	16,235	69,642		1,172,075	5,545,000	4.73	1,213	580	184	1,977	222
Missouri	3,101,275	211,447	90,429		3,403,151	11,575,000	3.40	4,217	1,335	1,400	6,952	155
Montana	2,934,829	118,060	94,789		3,147,678	9,652,000	3.07	2,054	910	547	3,511	179
New Mexico	2,572,465	38,684	46,689	257,335	2,915,173	10,668,000	3.66	2,522	1,025	548	4,095	216
North Carolina	29,419	1,700	4,900		36,019	132,000	3.66	55	70	25	150	275
North Dakota	1,128,318	218,574	38,508		1,385,400	3,275,000	2.36	883	257	481	1,621	182
Ohio	37,273,886	2,672,268	600,289		40,546,443	98,610,000	2.43	34,121	12,225	8,209	54,555	150
Oklahoma	2,722,387	37,998	117,022	7,631	2,885,038	10,874,000	3.77	4,100	1,930	1,100	7,130	133
Pennsylvania (bituminous)	138,275,133	7,359,213	2,507,227	23,738,340	171,879,913	472,217,000	2.75	120,385	46,183	28,413	194,981	213
South Dakota	2,000	8,379			10,379	25,000	2.41	34			34	122
Tennessee	5,614,117	119,657	115,783	190,711	6,040,268	16,515,000	2.73	6,752	2,733	1,759	11,244	183
Texas	1,156,901	6,564	23,864		1,187,329	2,162,000	1.82	1,641	493	318	2,452	178
Utah	4,179,293	56,471	81,399	403,054	4,720,217	13,657,000	2.89	2,379	1,063	939	4,381	160
Virginia	10,292,691	212,131	96,041	1,160,780	11,761,643	32,468,000	2.76	6,810	4,841	2,469	14,120	212
Washington	2,697,984	80,881	87,973	59,554	2,926,392	10,894,000	3.72	2,313	1,147	846	4,306	213
West Virginia	101,961,199	3,841,346	758,904	1,338,492	107,899,941	285,481,000	2.65	62,676	35,207	19,417	117,300	169
Wyoming	7,264,816	97,567	212,648		7,575,031	20,916,000	2.76	4,203	2,020	1,306	7,529	192
Total bituminous	505,859,295	22,081,040	8,765,011	27,859,316	564,564,662	1,514,621,000	2.68	422,040	178,265	104,488	704,793	179
Pennsylvania anthracite	82,239,037	3,248,352	7,851,620		93,339,009	506,786,768	5.43	72,362	42,359	43,022	157,743	268
Grand total	588,098,332	25,329,392	16,616,631	27,859,316	657,903,671	2,021,408,000	3.07	494,402	220,624	147,510	862,536	195

Anthracite produced in the United States in 1923, by regions

Region	Shipments		Local sales		Colliery fuel		Total production		Number of men employed				Average number of days worked
	Long tons	Value [a]	Long tons	Value	Long tons	Value	Long tons	Value [a]	Surface	Underground		Total	
										Miners [b]	All others		
Lehigh:													
Breaker product	9,538,147	$62,782,100	558,796	$2,135,158	1,008,884	$1,752,849	11,105,827	$66,670,107	6,423	8,189	5,714	20,326	274
Washery product	521,744	1,675,656	3,383	3,403	19,363	68,881	544,490	1,747,940	299	----------	----------	299	191
Dredge product	94,725	124,538	----------	----------	----------	----------	94,725	124,538	14	----------	----------	14	153
	10,154,616	64,582,294	562,179	2,138,561	1,028,247	1,821,730	11,745,042	68,542,585	6,736	8,189	5,714	20,639	273
Schuylkill:													
Breaker product	20,377,383	133,635,367	554,910	3,570,662	2,626,295	1,887,047	23,558,588	139,093,076	15,062	20,860	11,717	47,639	275
Washery product	1,552,511	6,185,369	186	1,110	59,537	47,550	1,612,234	6,234,029	1,354	----------	----------	1,354	226
Dredge product	284,682	306,184	462,231	369,520	6,370	5,107	753,283	680,811	357	----------	----------	357	207
	22,214,576	140,126,920	1,017,327	3,941,292	2,692,202	1,939,704	25,924,105	146,007,916	16,773	20,860	11,717	49,350	273
Wyoming:													
Breaker product	39,092,074	270,555,028	1,308,115	7,761,854	3,110,108	4,353,633	43,510,297	282,670,515	18,308	42,956	24,750	86,014	264
Washery product	1,680,032	7,215,898	4,852	14,611	174,518	352,536	1,859,402	7,583,045	961	----------	----------	961	211
Dredge product	5,592	5,476	----------	----------	300	240	5,892	5,716	3	----------	----------	3	98
	40,777,698	277,776,402	1,312,967	7,776,465	3,284,926	4,706,409	45,375,591	290,259,276	19,272	42,956	24,750	86,978	264
Sullivan county:													
Breaker product	280,822	1,912,541	7,841	51,450	5,000	13,000	293,663	1,976,991	241	357	178	776	241
Total breaker product	69,288,426	468,885,036	2,429,662	13,519,124	6,750,287	8,006,529	78,468,375	490,410,689	[c] 40,034	72,362	42,359	154,755	269
Total washery product	3,754,287	15,076,923	8,421	19,124	253,418	468,967	4,016,126	15,565,014	2,614	----------	----------	2,614	216
Total dredge product	384,999	436,198	462,231	369,520	6,670	5,347	853,900	811,065	374	----------	----------	374	204
Grand total	73,427,712	484,398,157	2,900,314	13,907,768	7,010,375	8,480,843	83,338,401	506,786,768	43,022	72,362	42,359	157,743	268

[a] Value given for shipments is value at which coal left possession of producing company f. o. b. mines and does not include margins of separately incorporated selling companies.
[b] Operators were requested to give number of "all miners (contract, consideration, and company) and their laborers."
[c] Inclusive of comparatively small number of washery employees. Figures not separable from those of breaker employees.

IMPORTS AND EXPORTS

Coal imported for consumption in the United States, 1919–1923

Year	Anthracite		Bituminous		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1919	82,818	$522,419	1,011,550	$4,950,686	1,094,368	$5,473,105
1920	31,748	257,835	1,244,990	6,733,676	1,276,738	6,991,511
1921	8,894	93,103	1,257,589	7,363,945	1,266,483	7,457,048
1922	233,528	1,502,192	5,059,999	26,747,374	5,293,527	28,249,566
1923	300,360	2,114,080	1,881,465	10,128,516	2,181,825	12,242,596

Coal exported from the United States, 1919–1923

Year	Anthracite		Bituminous [a]		Total [a]	
	Short tons	Value	Short tons	Value	Short tons	Value
1919	4,976,598	$36,668,131	20,113,536	$83,708,842	25,090,134	$120,376,973
1920	5,403,749	45,538,100	38,517,084	304,273,241	43,920,833	349,811,341
1921	4,677,368	45,624,555	23,131,166	122,597,038	27,808,534	168,221,593
1922	2,649,457	25,350,677	12,413,085	65,891,740	15,062,542	91,242,417
1923	5,090,138	49,577,339	21,453,579	104,546,585	26,543,717	154,123,924

[a] Exclusive of bunker coal, which has been as follows: 1919, 8,223,862 short tons, valued at $48,205,675; 1920, 10,485,639 tons, $82,461,518; 1921, 8,453,220 tons, $52,277,668; 1922, 4,614,632 tons, $27,912,957; and 1923, 5,093,024 tons, $31,469,788.

COBALT

PRODUCTION

No cobalt ore is known to have been produced in the United States during 1923. A carload of heterogenite (cobalt oxide) mined by Harvey Hardy and associates in 1921 near Good Springs, Nev., was shipped in 1922, and two other small shipments were made. The carload weighed 42,086 pounds, contained 4,018 pounds of cobalt, and sold for $1,419. No other cobalt ores are known to have been mined in the United States in either 1922 or 1921. In 1920 cobalt ores were mined only in Missouri, where the Missouri Cobalt Co. recovered 102,410 pounds of cobalt oxide and cobalt hydrate, valued at $262,801, from ore mined on its property near Fredericktown. The company operated only part of the year. In 1919 cobalt ores were mined in Idaho and Missouri. In Idaho the Haynes Stellite Co. produced concentrates carrying approximately 18 per cent of cobalt, and in Missouri the Missouri Cobalt Co. shipped cobalt oxide mined and reduced at its property near Fredericktown. In 1918 cobalt ores were mined only in Idaho, where the Haynes Stellite Co. produced 55 tons of concentrates, carrying 17.74 per cent of cobalt (19,514 pounds), from 4,000 tons of ore.

IMPORTS

Most of the cobalt used in this country has been imported from Canada, where it is obtained as a by-product from silver ores mined in the Cobalt district.

Cobalt ore, cobalt, zaffer, and oxide imported for consumption in the United States, 1919–1923

Year	Ore		Cobalt		Zaffer		Oxide		Total	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
1919	17,045	$2,832	60,511	$141,450			131,424	$184,751	208,980	$329,033
1920	13,039	4,794	143,603	326,864	220	$14	202,724	399,605	359,586	731,277
1921	7,657	3,235	38,442	105,539			164,003	342,426	210,102	451,200
1922	5,195	7,075	126,364	321,396			217,530	435,895	[a]349,089	[a] 764,366
1923	58,719	56,326	225,639	552,434			258,574	511,903	[a]542,932	[a]1,120,663

[a] Also 11 pounds of "other salts and compounds," valued at $26, imported Sept. 22 to Dec. 31, 1922. Not separately classified prior to new tariff. Similar additional imports in 1923 were 45,644 pounds, valued at $27,356.

COKE

PRODUCTION

Coke produced in the United States, 1919–1923

Year	Beehive		By-product		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1919	19,042,936	$98,094,972	25,137,621	$160,244,768	44,180,557	$258,339,740
1920	20,511,092	162,952,483	30,833,951	313,028,732	51,345,043	475,981,215
1921	5,538,042	30,166,449	19,749,580	117,506,646	25,287,622	147,673,095
1922	8,573,467	50,036,556	28,550,545	188,276,767	37,124,012	238,313,323
1923	19,379,870	115,905,580	37,597,664	257,591,318	56,977,534	373,496,898

Coke produced in the United States, 1922 and 1923, by States

State	1922		1923	
	Short tons	Value [a]	Short tons	Value [a]
Alabama	3,799,865	$14,708,245	4,654,075	$19,817,394
Colorado	484,039	[b]	647,823	[b]
Georgia	8,832	74,807	12,556	126,690
Illinois	1,982,906	18,164,549	3,187,168	30,373,638
Indiana	3,995,505	28,978,431	5,042,614	46,765,264
Kentucky	487,167	3,614,140	559,711	[b]
Maryland	589,893	[b]	861,668	[b]
Massachusetts	407,081	[b]	554,125	[b]
Michigan	1,142,059	9,229,083	1,648,773	14,389,742
Minnesota	462,044	4,641,871	695,824	5,104,330
Missouri	[c]	[c]	[c]	[c]
New Jersey	790,811	[b]	897,569	[b]
New Mexico	87,631	788,679	[c]	[c]
New York	1,494,992	11,865,785	1,783,948	12,808,335
Ohio	5,011,138	33,100,323	6,473,606	[b]
Oklahoma			[c]	[c]
Pennsylvania	13,991,892	74,794,560	25,624,286	138,444,191
Rhode Island	[c]	[c]	[c]	[c]
Tennessee	113,896	820,878	304,511	2,069,553
Utah	172,453	1,406,109	232,941	1,977,669
Virginia	378,656	2,291,336	774,887	5,086,612
Washington	31,674	285,881	69,068	584,512
West Virginia	919,744	6,112,387	1,762,775	11,103,716
Wisconsin	[c]	[c]	[c]	[c]
Combined States	771,734	7,520,701	1,189,606	13,083,700
Undistributed		19,915,558		71,761,552
	37,124,012	238,313,323	56,977,534	373,496,898

[a] Includes operators' statements of value for that portion of product not sold (such as coke consumed by producer in associated iron furnaces).
[b] Included under "Undistributed."
[c] Included under "Combined States."

Beehive coke produced in the United States, 1922 and 1923, by States

State	1922		1923	
	Short tons	Value	Short tons	Value
Alabama	306,209	$1,735,406	268,709	$1,660,903
Colorado	119,361	821,309	199,580	(a)
Georgia	8,832	74,807	12,556	126,690
Kentucky	30,522	216,701	125,595	874,752
New Mexico	87,631	788,679	(b)	(b)
Ohio	99,468	713,186	149,796	(a)
Oklahoma			(b)	(b)
Pennsylvania	6,839,980	38,091,586	16,438,539	94,923,942
Tennessee	86,442	618,542	180,351	1,244,011
Utah	172,453	1,406,100	232,941	1,977,669
Virginia	378,656	2,291,336	774,887	5,086,612
Washington	26,063	241,442	37,987	347,364
West Virginia	417,850	3,037,453	821,909	5,758,284
Combined States			137,020	1,157,400
Undistributed				2,747,953
	8,573,467	50,086,556	19,379,870	115,905,580

a Included under "Undistributed."
b Included under "Combined States."

By-product coke produced in the United States, 1922 and 1923, by States

State	1922		1923	
	Short tons	Value	Short tons	Value
Alabama	3,493,656	$12,972,839	4,385,366	$18,156,491
Colorado	364,678	(a)	448,243	(a)
Illinois	1,982,906	18,164,549	3,187,168	30,373,638
Indiana	3,995,505	28,978,431	5,042,614	46,765,264
Kentucky	456,645	3,397,439	434,116	(a)
Maryland	589,893	(a)	861,668	(a)
Massachusetts	407,081	(a)	554,125	(a)
Michigan	1,142,059	9,229,083	1,648,773	14,389,742
Minnesota	462,044	4,641,871	695,824	5,104,330
New Jersey	790,811	(a)	897,569	(a)
New York	1,494,992	11,865,785	1,783,948	12,808,335
Ohio	4,911,670	32,387,137	6,323,810	40,712,282
Pennsylvania	7,151,912	36,702,974	9,185,747	43,520,249
Tennessee	27,454	202,336	124,160	825,542
Washington	5,611	44,439	31,081	237,148
West Virginia	501,894	3,074,934	940,866	5,345,432
Missouri	771,734	7,520,701	1,052,586	11,926,300
Rhode Island				
Wisconsin				
Undistributed		19,094,249		27,426,565
	28,550,545	188,276,767	37,597,664	257,591,318

a Included under "Undistributed."

Coke produced in the United States in 1923, by months, in short tons

Month	Beehive	By-product	Total
January	1,594,000	3,102,000	4,696,000
February	1,598,000	2,862,000	4,460,000
March	1,886,000	3,258,000	5,144,000
April	1,914,000	3,208,000	5,122,000
May	1,972,000	3,330,000	5,302,000
June	1,892,000	3,168,000	5,060,000
July	1,706,000	3,268,000	4,974,000
August	1,611,000	3,241,000	4,852,000
September	1,480,000	3,115,000	4,595,000
October	1,391,000	3,102,000	4,493,000
November	1,189,000	2,943,000	4,132,000
December	1,147,000	3,001,000	4,148,000
Total, 1923	19,380,000	37,598,000	56,978,000
Monthly average: 1923	1,615,000	3,133,000	4,748,000
1922	714,000	2,379,000	3,093,000
1921	462,000	1,646,000	2,108,000
1920	1,709,000	2,569,000	4,278,000

IMPORTS AND EXPORTS

Coke imported into and exported from the United States, 1919–1923

Year	Imports for consumption		Exports	
	Short tons	Value	Short tons	Value
1919	16,486	$140,653	716,956	$5,128,119
1920	41,143	403,175	919,802	9,993,665
1921	30,990	336,394	306,755	2,760,939
1922	94,228	802,987	511,541	4,319,538
1923	85,002	862,596	1,237,342	11,889,897

COKE-OVEN BY-PRODUCTS

By-products from coke-oven operations in the United States, 1922 and 1923

Product	Produced	Sold	
		Quantity	Value
1922			
Tar—gallons	327,779,734	162,204,417	$6,419,743
Ammonia:			
Sulphate—pounds	695,543,349	714,752,882	17,818,236
Ammonia liquor (NH_3 content)—do	50,036,646	48,523,937	4,559,535
Other forms (NH_3 content)—do	693,782	192,549	12,041
Sulphate equivalent of all forms—do	(898,465,061)	(909,618,826)	22,389,812
Gas:			
Distributed through city mains—M cu. ft	[a] 442,671,114	56,930,253	20,326,648
Used in steel or affiliated plant—do		144,976,030	15,942,446
Used under boilers, etc—do		19,123,814	1,251,325
Sold for industrial use—do		10,352,921	1,104,901
			38,625,320
Light oil and derivatives:			
Crude light oil—gallons	[b] 101,437,555	5,138,095	630,768
Benzol: crude—do	2,666,177	2,665,889	698,437
Benzol: refined—do	10,419,504	9,590,459	2,736,944
Motor benzol—do	57,025,699	54,930,203	10,491,309
Toluol: crude—do	38,159	3,938	652
Toluol: refined—do	1,955,119	1,906,122	556,363
Solvent naphtha—do	2,983,858	2,861,482	538,512
Other light-oil products—do	580,058	212,712	14,949
			15,667,934
Naphthalene: crude—pounds	6,107,742	3,298,851	52,103
Naphthalene: refined—do	1,810,972	1,589,084	79,149
			131,252
Other products			154,507
			[c] 83,388,568

[a] Inclusive of gas wasted and gas used for heating retorts.
[b] Of the crude light oil 98,432,100 gallons (including 4,200,000 gallons of purchased oil) was refined on the premises to make the derived products listed.
[c] Exclusive of value of coke breeze.

By-products from coke-oven operations in the United States, 1922 and 1923—Contd.

Product	Produced	Sold	
		Quantity	Value
1923			
Tar, gallons	440, 907, 109	211, 739, 469	$9, 250, 552
Ammonia:			
Sulphate, pounds	915, 926, 762	884, 952, 912	25, 954, 413
Ammonia liquor (NH_3 content) [a], do	58, 699, 902	57, 859, 699	5, 754, 463
Sulphate equivalent of all forms, do	(1, 150, 726, 370)	(1, 116, 391, 708)	31, 708, 876
Gas:			
Distributed through city mains, M cu. ft	[b] 601, 155, 293	65, 143, 515	23, 116, 578
Used in steel or affiliated plant, do		200, 099, 200	22, 646, 134
Used under boilers, etc, do		33, 740, 758	1, 820, 808
Sold for industrial use, do		19, 458, 781	4, 025, 700
			51, 609, 220
Light oil and derivatives:			
Crude light oil, gallons	[c] 135, 647, 175	6, 539, 368	683, 545
Benzol: crude, do	4, 503, 428	4, 348, 400	768, 486
Benzol: refined, do	12, 364, 043	12, 375, 782	3, 070, 751
Motor benzol, do	80, 467, 883	80, 480, 326	13, 145, 833
Toluol: crude, do	37, 777	6, 097	978
Toluol: refined, do	2, 847, 517	2, 628, 686	765, 052
Solvent naphtha, do	4, 162, 178	3, 399, 904	608, 084
Other light-oil products, do	439, 253	198, 098	10, 605
			19, 053, 334
Naphthalene: crude, pounds	11, 872, 007	10, 047, 427	174, 216
Naphthalene: refined, do	1, 139, 922	1, 198, 206	65, 483
			239, 699
Other products			214, 264
			[d] 112, 075, 945

[a] Includes an unknown quantity of sulphate sold on basis of NH_3 content.
[b] Inclusive of gas wasted and gas used for heating retorts.
[c] Of the crude light oil 132,517,389 gallons was refined on the premises to make the derived products listed.
[d] Exclusive of value of coke breeze.

COPPER

SUMMARY OF STATISTICS

Summary of statistics of the copper industry in the United States, 1921–1923

	1921	1922	1923
Production of copper:			
Smelter output, pounds	505, 586, 098	950, 285, 947	1, 434, 999, 962
Mine production, do	466, 190, 853	964, 583, 894	1, 477, 739, 709
Refinery production of new copper—			
Electrolytic, do	506, 532, 984	766, 944, 836	1, 302, 454, 492
Lake, do	100, 918, 001	122, 545, 126	137, 691, 306
Casting and pig, do	1, 963, 271	15, 180, 723	24, 019, 197
Total domestic, do	609, 414, 256	904, 670, 685	1, 464, 164, 995
Total domestic and foreign, do	950, 777, 815	1, 255, 515, 959	1, 979, 835, 616
Total new and old copper, do	1, 385, 000, 000	1, 927, 000, 000	2, 802, 000, 000
Ore produced:			
Copper ore, short tons	13, 396, 382	26, 893, 247	45, 519, 317
Average yield of copper, per cent	1. 70	1. 74	1. 58
Copper-lead and copper-zinc ores, short tons	14, 248	52, 370	162, 181
Average price per pound, cents	12. 9	13. 5	14. 7
Imports (unmanufactured), pounds	350, 472, 611	541, 013, 220	676, 473, 338
Exports of metallic copper [a], do	628, 415, 714	742, 755, 957	828, 854, 827
Withdrawn from total supply on domestic account:			
Total new copper, pounds	610, 988, 744	896, 633, 833	1, 300, 473, 331
Total new and old copper, do	1, 046, 000, 000	1, 568, 000, 000	2, 122, 000, 000
Stocks at end of year:			
Refined copper, do	459, 000, 000	216, 000, 000	264, 000, 000
Blister and materials in solution, do	283, 000, 000	361, 000, 000	432, 000, 000
World's production, do	1, 227, 974, 000	1, 862, 906, 000	[b]
Value of smelter production from domestic ores	$65, 221, 000	$128, 289, 000	$210, 945, 000

[a] Total exports of copper, exclusive of ore, concentrates, and composition metal, and, in 1923, of a small quantity of unrefined black blister for which figures are not separable from those for ore and concentrates.
[b] Figures not yet available.

PRODUCTION

Copper produced in the United States from domestic ores, 1920–1923

[Smelter output, in pounds fine]

State	1920	1921	1922	1923
Alaska	66,093,924	76,808,114	59,900,579	68,648,368
Arizona	552,988,731	155,165,656	428,200,634	615,493,561
California	11,822,028	15,906,883	20,440,430	27,042,835
Colorado	4,282,616	6,592,598	3,635,916	4,343,418
Georgia	3,663		8,147	
Idaho	1,922,116	1,971,623	3,504,944	3,664,079
Maine		3		
Michigan	153,483,952	100,918,001	122,545,126	137,691,306
Missouri	533,368	137,591	1,070,259	217,449
Montana	177,743,747	49,471,206	165,341,414	224,353,764
Nevada	55,580,322	15,129,116	20,398,611	63,495,928
New Mexico	52,159,751	18,076,909	29,127,329	57,521,171
North Carolina				61,913
Oregon	2,529,311	274,934	925,954	1,182,437
Pennsylvania	618,361		888,721	1,121,573
South Dakota	2,190			47
Tennessee	16,727,803	15,084,294	14,226,232	18,721,932
Texas	14,217	587	3,889	4,216
Utah	110,357,748	45,831,959	79,665,563	210,118,291
Washington	2,125,586	598,658	369,133	839,254
Wyoming	24,256	9,830		87,686
Undistributed	47,350	3,608,136	33,066	390,734
	1,209,061,040	505,586,098	950,285,947	1,434,999,962

Primary and secondary copper produced by regular refining plants in the United States and imported, 1920–1923, in pounds

	1920	1921	1922	1923
Primary:				
Domestic [a]—				
Electrolytic	1,010,240,867	506,532,984	766,944,836	1,302,454,492
Lake	153,483,952	100,918,001	122,545,126	137,691,306
Casting	13,905,114	1,740,393	15,180,723	24,019,197
Pig and best select	4,793,307	222,878		
	1,182,423,240	609,414,256	904,670,685	1,464,164,995
Foreign [a]—				
Electrolytic	341,451,660	336,088,209	345,641,677	509,873,512
Casting and best select	2,290,446	5,275,350	5,203,597	5,797,109
Total refinery production of new copper	1,526,165,346	950,777,815	1,255,515,959	1,979,835,616
Imports of refined copper	108,743,298	69,249,281	103,143,142	[b] 160,711,227
Total new refined copper made available	1,634,908,644	1,020,027,096	1,358,659,101	2,140,546,843
Secondary:				
Electrolytic	32,856,549	82,017,382	100,792,685	85,297,052
Casting	49,130,510	24,467,951	45,217,857	46,141,409
	81,987,059	106,485,333	146,010,542	131,438,461
	1,716,895,703	1,126,512,429	1,504,669,643	2,271,985,304

[a] The separation of refined copper into metal of domestic and foreign origin is only approximate, as an accurate separation at this stage of manufacture is not possible.

[b] Figures of imports of refined copper from Chile, as reported by the Chile Exploration Co., have been included here in place of those of the Bureau of Foreign and Domestic Commerce for Chile, which are undoubtedly very low.

In addition to their output of metallic copper the regular refining companies produced in 1923 bluestone having a copper content of 7,987,000 pounds, as compared with 8,508,000 pounds in 1922.

STOCKS

Stocks of refined copper in the United States, January 1, 1920–1924

	Pounds
Jan. 1, 1920	631,000,000
Jan. 1, 1921	659,000,000
Jan. 1, 1922	459,000,000
Jan. 1, 1923	216,000,000
Jan. 1, 1924	264,000,000

In addition to the stocks of refined copper on hand, January 1, 1924, 432,000,000 pounds of blister copper and materials in process of refining was reported as at smelters in the United States, in transit from smelters to refiners, and at refineries, against 361,000,000 pounds on January 1, 1923.

CONSUMPTION

New refined copper withdrawn from total year's supply on domestic account in the United States, 1920–1923, in pounds

	1920	1921	1922	1923
Total supply of new copper	1,634,908,644	1,020,027,096	1,358,659,101	2,140,546,843
Stocks at beginning of year	631,000,000	659,000,000	459,000,000	216,000,000
Total available supply	2,265,908,644	1,679,027,096	1,817,659,101	2,356,546,843
Copper exported [a]	553,070,086	609,038,352	705,025,268	[b] 792,073,512
Stocks at end of year	659,000,000	459,000,000	216,000,000	264,000,000
	1,212,070,086	1,068,038,352	921,025,268	1,056,073,512
Withdrawn on domestic account	1,053,838,558	610,988,744	896,633,833	1,300,473,331

[a] Includes unrefined black blister and converter copper (bars, pigs, and other forms) and refined in ingots, bars, rods, or other forms.

[b] Exclusive of small quantity of unrefined black blister for which figures are not separable from those for ore and concentrates.

IMPORTS AND EXPORTS

Copper (in unmanufactured form) imported for consumption in the United States, 1918–1923

Year	Pounds	Value	Year	Pounds	Value
1918	569,182,467	$131,064,639	1921	350,582,746	$45,660,326
1919	437,570,497	88,751,115	1922	542,932,525	65,786,811
1920	480,297,985	88,782,609	1923	671,929,223	95,398,681

Copper (unmanufactured) imported into the United States, 1922 and 1923, in pounds

[General imports]

Country	Ore (copper content)	Concentrates (copper content)	Matte and regulus (copper content)	Unrefined black copper and copper in bars, pigs, or other forms	Refined in bars, plates, rods, or other forms	Old and clippings for remanufacture	Composition metal, copper chief value
1922							
United Kingdom	2,396,043	1,737,707	119,575	23,241,088	2,739,701	11,556,767	719,034
France	168,591	5,980	394,277	532,003	3,145,752	4,704,910	
Germany	1,114,096		1,591,619		708,514	277,153	175,662
Spain	7,001,731		70,000	13,916,628			
Canada	2,567,149	696,296	283,703	46,211,714	7,532	3,522,162	2,810
Mexico	675,196	11,488,503	3,020,642	46,015,417	47,326	7,508	
Cuba	9,220,800	16,056,822				683,393	9,111
Bolivia	436,153	643,907	345	884,622	20,312	18,745	31
Chile	44,041,453	2,073,710	142,261	44,215,265	96,433,739	103,784	
Peru	1,013,165	104,646	500,340	81,853,488	19,113	39,113	
Venezuela	901,421		1,236,482			7,974	
Australia	24,408			1,850			
British South Africa	15,700	24,584				30,899	
Portuguese Africa		27,494		44,398,268			
Other countries	1,627,220	48,022	1,368,795	1,308,885	21,153	389,007	203,951
Total value	71,203,126	32,907,671	8,728,039	302,579,228	103,143,142	21,341,415	1,110,599
	$8,527,495	$3,326,761	$997,501	$37,723,598	$13,973,095	$2,012,560	$118,739
1923							
United Kingdom	102,398	200,485	46,563	556,959	1,617,790	1,904,531	1,492,817
France	336,978	6,097	33,500	2,813,867	3,786,859	34,026	
Germany	1,299,725		1,473	1,215,413		332,797	89,313
Spain	7,494,217	482,688		4,160,761	2,905,493		
Canada	19,374,037	279,003	2,192,826	42,514,549	1,054,078	1,771,377	373,787
Mexico	2,319,922	34,362,617		82,161,843		65,470	
Cuba	9,735,954	13,666,280	5,060	1,645		737,748	12,135
Bolivia	62			2,151,357	163,229		
Chile	45,044,926	22,982		106,077,067	118,446,874	176,641	2,232,393
Peru	1,182,890	229,795		77,893,297	113,268	13,300	
Venezuela	1,450,886	351,254				220	
Australia	107,246			2,872,973			
British South Africa	9,525	33,174					
Portuguese E. Africa	64,908			17,187,927			
Other Portuguese Africa				53,031,418	380,120		
Other countries	1,629,029	306,380	681,427	2,624,208	246	449,239	1,996
Total value	90,152,703	49,940,755	2,960,849	395,263,284	128,467,957	5,485,349	4,202,441
	$11,735,291	$6,861,987	$408,666	$56,563,515	$19,119,537	$606,485	$599,993

Copper exported from the United States, 1919–1923

Year	Pounds		Total value
	Metallic*	Total	
1919	515,595,019	516,627,775	$117,417,055
1920	623,158,489	624,053,701	127,468,606
1921	628,415,714	628,804,750	85,351,928
1922	742,755,957	743,039,888	103,874,007
1923	828,854,827	829,314,002	129,219,975

* Exclusive of ore, concentrates, and composition metal, and, in 1923, of a small quantity of unrefined black blister for which figures are not separable from those for ore and concentrates.

Copper exported from the United States, 1922 and 1923

	1922		1923	
	Pounds	Value	Pounds	Value
Ore, concentrates, matte, and regulus (copper content)	62,458	$8,543	339,212	$41,775
Unrefined black blister and converter copper (bars, pigs, and other forms)	169,733	21,027		
Refined in ingots, bars, or other forms	652,666,939	89,030,278	729,380,207	110,489,142
Rods	52,188,596	7,505,981	62,693,305	9,994,654
Composition metal, copper chief value	221,473	37,339	119,963	27,368
Old and scrap	2,800,862	338,912	3,544,545	478,695
Pipes and tubes	1,822,580	452,723	2,613,393	720,212
Plates and sheets	6,748,454	1,341,300	4,535,743	1,061,787
Wire (except insulated)	11,600,480	1,875,422	9,842,992	1,972,800
Insulated wire and cable	8,575,745	1,982,093	11,681,450	3,140,027
Other manufactures of copper	6,182,568	1,280,389	4,563,192	1,293,515
	743,039,888	103,874,007	829,314,002	129,219,975

PRICES

[See statement on page 16A]

CORUNDUM

[See Abrasive materials]

CRYOLITE

PRODUCTION

No natural cryolite is produced in the United States, the entire supply used in this country being imported from Greenland. Artificial cryolite is produced by electrochemical processes.

IMPORTS

Cryolite imported for consumption in the United States, 1918–1923

Year	Long tons	Value	Year	Long tons	Value
1918	1,950	$97,500	1921	3,460	$295,186
1919	2,131	106,956	1922	3,899	196,302
1920	3,864	193,638	1923	6,375	319,959

DIATOMACEOUS (INFUSORIAL) EARTH

[See Abrasive materials]

EMERY

[See Abrasive materials]

FELDSPAR

PRODUCTION

Crude feldspar, produced in the United States, sold in 1918–1923

Year	Long tons	Value	Year	Long tons	Value
1918	88,498	$429,989	1921	91,865	$617,652
1919	63,441	347,992	1922	117,127	844,568
1920	135,551	851,123	1923	145,004	1,057,595

Feldspar, produced in Canada, sold in 1918–1923 [a]

Year	Short tons	Value	Year	Short tons	Value
1918	18,782	$112,728	1921	29,868	$230,754
1919	14,679	86,231	1922	27,727	248,402
1920	37,873	280,895	1923	29,483	214,346

[a] 1918–1920: Canada Dept. Mines; 1921–1923: Dominion Bureau of Statistics.

IMPORTS AND EXPORTS

The foreign trade of the United States in feldspar is small and limited largely to importing from Canada. Imports in 1923 amounted to 24,271 long tons of crude feldspar, valued at $184,924. Prior to September 22, 1922, imports of feldspar were not specifically classified in the official records and are therefore unknown. From that date to the end of the year the imports amounted to 7,549 long tons of crude, valued at $60,111, and 37 long tons of crushed or ground, valued at $538.

There is no record of exports of feldspar, and if any is exported the quantity is doubtless negligible.

FERROALLOYS

PRODUCTION

Ferroalloys shipped from furnaces in the United States, 1919–1923, in long tons

Year	Ferro-manganese	Spiegeleisen	Other varieties	Total	
				Quantity	Value
1919	198,255	90,855	130,528	419,638	$53,730,964
1920	276,594	103,672	232,542	612,808	77,519,367
1921	111,374	69,230	68,023	248,627	21,697,785
1922	161,612	70,253	191,415	423,280	28,259,004
1923	226,365	134,086	219,366	579,817	49,877,231

Ferroalloys shipped from furnaces in the United States, 1922 and 1923

Variety of alloy	1922		1923	
	Long tons	Value	Long tons	Value
Ferromanganese	[a] 161,612	[a] $10,673,638	226,365	$23,853,313
Spiegeleisen	70,253	2,162,836	134,086	4,547,113
Ferrosilicon (7 per cent or more silicon)	154,866	7,109,928	184,067	9,940,772
Ferromolybdenum	108	267,168	118	297,842
Ferrotungsten	610	641,238	1,485	2,177,685
Ferrovanadium	903	2,516,109	1,432	3,765,344
Other varieties [b]	34,928	4,888,087	32,264	5,295,162
	423,280	28,259,004	579,817	49,877,231

[a] Includes a small quantity of silico-manganese.
[b] Ferrocarbide, ferrochromium, ferrophosphorus, ferrotitanium, ferrozirconium, and zirconium-ferrosilicon.

IMPORTS AND EXPORTS

Ferroalloys imported for consumption in the United States, 1922 and 1923

Variety of alloy	1922 [a]			1923 [a]	
	Long tons		Value	Long tons	Value
	Jan. 1 to Sept. 21	Sept. 22 to Dec. 31			
Chrome or chromium and ferrochromium [b]	390	7	$118,870	1,481	$281,279
Ferrosilicon	12,740	2,032	830,808	11,544	1,044,221
Molybdenum and ferromolybdenum	13		36,246	(c)	5
Titanium and ferrotitanium	8	16	11,607	6	2,949
Tungsten and ferrotungsten	463	14	394,727	35	25,907
Ferrovanadium		(d)	3,770		
Ferromanganese	72,136	22,871	6,125,469	91,066	8,357,023
Spiegeleisen	3,899	4,252	268,135	4,668	165,791
			7,789,632		9,877,175

[a] Prior to Sept. 22, 1922, figures represent gross weight of the ferroalloy. Since that date the figures represent the weight of the chromium, silicon, etc., content of the ferroalloy.
[b] Beginning with new tariff, Sept. 22, 1922, classification covers chromium metal, chromium-vanadium, and ferrochromium.
[c] 4 pounds.
[d] 1,160 pounds.

Ferroalloys exported from the United States, 1921–1923

Variety of alloy	1921		1922		1923	
	Long tons	Value	Long tons	Value	Long tons	Value
Ferromanganese	690	$100,474	1,107	$76,822	[a] 4,295	[a] $151,224
Spiegeleisen	(a)	(a)	289	7,740		
Ferrochrome and chrome metal	(a)	(a)	23	1,941	(a)	(a)
Ferrosilicon	368	20,204	689	30,939	814	31,154
Tungsten and ferrotungsten			(b)	43,219	[c] 2	[c] 122,906
Ferrovanadium	98	424,886	22	69,279	23	64,713

[a] Not separately classified.
[b] 1,009 pounds.
[c] Includes also tungsten wire.

PRICES

Prices per ton of ferromanganese and spiegeleisen in the United States, 1921–1923, by months [a]

Month	Ferromanganese (80 per cent Mn., delivered at Pittsburgh)			Spiegeleisen (20 per cent Mn., at producer's furnace)		
	1921	1922	1923	1921	1922	1923
January	$101.00	$61.90	$109.79	$46.25	$25.50	$34.90
February	96.85	65.32	112.29	37.75	28.00	35.75
March	89.00	67.82	120.79	34.20	28.00	37.25
April	87.50	69.07	124.79	32.00	30.00	39.25
May	83.00	72.32	129.79	31.75	35.00	43.00
June	76.50	72.82	129.79	29.60	35.25	46.00
July	75.00	72.29	122.29	27.50	35.00	45.00
August	70.75	72.29	122.29	26.20	37.00	45.00
September	64.75	80.59	114.79	25.25	38.00	43.50
October	61.65	105.47	112.79	24.85	37.75	40.00
November	60.00	104.92	113.79	25.00	36.80	39.00
December	60.00	104.92	113.79	25.00	35.50	39.00

[a] Iron Trade Review.

FLUORSPAR

PRODUCTION

Fluorspar shipped from mines in the United States, 1918–1923

Year	Short tons	Value	Year	Short tons	Value
1918	263,817	$5,465,481	1921	34,960	$724,094
1919	138,290	3,525,574	1922	141,596	2,531,165
1920	186,778	4,718,547	1923	121,188	2,505,819

Fluorspar shipped from mines in the United States, 1922 and 1923, by States

State	1922		1923	
	Short tons	Value	Short tons	Value
Colorado	2,309	$20,169	6,044	$59,710
Illinois	83,855	1,493,188	65,045	1,443,490
Kentucky	52,484	970,059	45,441	945,402
New Mexico	2,180	30,992	4,328	50,861
New Hampshire	768	16,757	142	6,356
Utah			188	
	141,596	2,531,165	121,188	2,505,819

IMPORTS AND EXPORTS

Fluorspar imported for consumption in the United States, 1918–1923

Year	Short tons	Value	Year	Short tons	Value
1918	12,572	$169,364	1921	6,229	$69,306
1919	6,943	107,631	1922	33,108	299,188
1920	24,612	265,630	1923	41,884	429,696

No exports of fluorspar have been reported by Bureau of Foreign and Domestic Commerce. Producers reported 2,764 tons, valued at $65,475, exported in 1920, 2,296 tons, valued at $40,966, in 1922, and 1,144 tons, valued at $25,312, in 1923.

FULLER'S EARTH

PRODUCTION

Fuller's earth, produced in the United States, sold in 1918–1923

Year	Number of operators	Short tons	Value	Year	Number of operators	Short tons	Value
1918	14	84,468	$1,146,354	1921	12	105,609	$1,973,848
1919	10	106,145	1,998,829	1922	15	138,944	2,289,719
1920	12	128,487	2,506,189	1923	15	149,134	2,247,523

IMPORTS

Fuller's earth imported for consumption in the United States, 1918–1923

Year	Short tons	Value	Year	Short tons	Value
1918	16,922	$226,235	1921	9,744	$119,415
1919	13,873	189,711	1922	10,569	135,695
1920	19,015	221,893	1923	8,547	113,944

Exports of fuller's earth are not reported separately.

GARNET (ABRASIVE)

[See Abrasive materials]

GAS (NATURAL)

Natural gas produced in the United States and delivered to consumers, 1918–1923

Year	M cubic feet	Value	Year	M cubic feet	Value
1918	721,000,959	$153,553,560	1921	662,052,000	$174,617,000
1919	745,916,000	160,888,000	1922	762,546,000	221,535,000
1920	798,210,000	196,194,000	1923	1,008,135,000	239,966,000

Natural gas produced in the United States and delivered to consumers, 1922 and 1923, by States

[Value is at point of consumption]

State	1922		1923	
	M cubic feet	Value	M cubic feet	Value
Arkansas	9,700,000	$1,798,000	24,215,000	$3,255,000
California	84,580,000	17,898,000	131,434,000	22,787,000
Colorado	4,000	560	800	400
Illinois	3,383,000	424,040	4,049,000	690,000
Indiana	947,000	476,172	880,000	460,000
Iowa	500	250	[a]	[a]
Kansas	20,289,000	9,123,000	32,072,000	11,304,000
Kentucky	5,872,000	1,879,000	11,953,000	3,156,000
Louisiana	70,267,000	5,849,000	112,031,000	6,022,000
Michigan	700	350	700	320
Missouri	2,600	2,028	17,000	12,000
Montana	486,000	88,300	1,470,000	317,000
New York	6,947,000	3,379,000	6,497,000	3,739,000
North Dakota	600	300	[a]	[a]
Ohio	51,481,000	24,181,000	53,812,000	25,675,000
Oklahoma	140,631,000	33,475,800	203,082,000	31,126,000
Pennsylvania	101,276,000	39,835,000	112,562,000	45,873,000
South Dakota	15,600	6,400	33,000	16,600
Tennessee	3,000	800	4,100	1,000
Texas	47,945,000	10,623,000	74,535,000	11,320,000
West Virginia	195,288,000	69,464,000	203,867,000	69,981,000
Wyoming	23,427,000	3,031,000	35,523,000	4,222,000
Other [b]			97,400	8,680
	762,546,000	221,535,000	1,008,135,000	239,966,000

[a] Included under "Other."
[b] Alaska, Iowa, New Mexico, and North Dakota.

GASOLINE FROM NATURAL GAS

Natural-gas gasoline produced in the United States, 1919–1923

Year	Raw (unblended) gasoline produced		Natural gas treated (estimate) (M cubic feet)
	Gallons	Value at plant	
1919	351, 535, 026	$64, 196, 763	480, 404, 000
1920	384, 743, 922	71, 788, 122	496, 431, 000
1921	449, 934, 402	61, 815, 258	465, 097, 000
1922	505, 832, 000	72, 711, 063	545, 139, 000
1923	816, 226, 000	77, 268, 000	875, 711, 000

Natural-gas gasoline produced in the United States, 1922 and 1923, by States

State	1922		1923	
	Gallons	Value	Gallons	Value
Arkansas	4, 288, 955	$629, 491	16, 183, 000	$1, 916, 000
California	67, 119, 700	11, 868, 152	173, 329, 000	16, 564, 000
Illinois	7, 760, 611	1, 181, 797	7, 356, 000	851, 000
Kansas	2, 855, 573	435, 056	8, 775, 000	690, 000
Kentucky	5, 204, 883	925, 810	7, 601, 000	1, 067, 000
Louisiana	29, 406, 282	4, 112, 655	40, 720, 000	3, 484, 000
New York	506, 200	61, 415	408, 000	44, 000
Ohio	8, 600, 296	1, 300, 929	10, 035, 000	1, 446, 000
Oklahoma	189, 403, 670	24, 914, 048	270, 249, 000	23, 012, 000
Pennsylvania	18, 518, 131	3, 144, 545	19, 132, 000	2, 560, 000
Texas	95, 405, 483	12, 114, 952	177, 765, 000	14, 752, 000
West Virginia	56, 795, 713	9, 770, 884	63, 381, 000	8, 890, 000
Wyoming	19, 967, 103	2, 251, 329	21, 292, 000	1, 992, 000
	505, 832, 000	72, 711, 063	816, 226, 000	77, 268, 000

GEMS AND PRECIOUS STONES

PRODUCTION

Value of precious stones produced in the United States, 1919–1923

Variety	1919	1920	1921	1922	1923 (estimate)
Agalmatolite		[a]			[a]
Andalusite			$10		
Beryl	[a]	$3, 440	1, 090	[a]	
Chlorastrolite	$53	[a]	100	$100	
Copper-ore gems	[a]	[a]	8, 775	340	
Corundum (sapphire)	40, 304	214, 705	482, 745	50, 727	
Datolite	[a]	[a]			
Diamond	[a]	[a]	[b]	[b] 1, 200	
Epidote		[a]			
Feldspar	[a]	520	155	73	
Fossil coral	[a]		200	[a]	
Garnet	1, 630	331	606	136	
Hematite	[a]	45			
Iceland spar	[a]	398	[a]	338	
Jet	[a]	[a]	460	[a]	
Lapis lazuli	[a]				
Meerschaum (sepiolite)	[a]				
Obsidian		40	67	6	[a]
Olivine		100			
Opal	[a]	[a]	336	[a]	
Pyrite		[a]			
Quartz	17, 632	14, 676	11, 114	5, 318	
Rhodonite	160	[a]	275	[a]	
Smithsonite			[a]		
Spinel	[a]	[a]		[a]	
Spodumene	[a]			[a]	
Staurolite		[a]			
Thomsonite	[a]	10	10	[a]	
Topaz	210	767	[a]	[a]	
Tourmaline	17, 700	4, 869	1, 450	1, 878	
Turquoise	22, 750	16, 865	6, 272	6, 928	
Variscite	925	[a]	560	658	
Zircon		144			
Zoisite				[a]	
Undistributed	10, 399	8, 295	4, 055	3, 404	
	111, 763	265, 205	[b] 518, 280	[b] 71, 106	$65, 000

[a] Included under "Undistributed." [c] Value by varieties not available.
[b] Production of diamond in Arkansas not reported.

IMPORTS AND EXPORTS

Value of diamonds and other precious stones imported for consumption in the United States, 1919–1923

Year	Diamonds				Other stones not set	Total excluding pearls	Pearls
	Glazier's	Dust and bort	Rough or uncut	Cut but not set			
1919	$984,381	$1,420,442	$20,306,758	$64,085,610	$5,161,639	$91,958,830	$11,008,973
1920	1,527,753	3,387,488	10,526,125	45,240,013	5,419,363	66,100,742	7,879,384
1921	435,872	466,345	2,207,365	26,144,323	2,778,931	32,032,836	4,492,063
1922	839,882	1,029,261	8,332,416	43,144,742	3,723,062	57,069,363	8,546,574
1923	1,065,834	228,409	7,241,550	51,975,896	5,703,279	66,214,968	7,932,929

Domestic exports in 1922 were as follows: "Diamonds, cut but not set," 15 carats, valued at $1,540; "other precious stones, including pearls," $21,525. Data are not separately classified prior to 1922. For 1923 domestic exports are recorded as "precious stones, including pearls," $42,483.

Value of foreign precious stones reexported from the United States, 1919–1923

Year	Diamonds		Other precious stones		Total excluding pearls	Pearls and parts of, not strung or set
	Uncut	Cut but not set	Uncut	Cut but not set		
1919	$3,238	$25,000	$15,653	$1,783	$45,674	$5,386
1920			4,604	13,338	17,942	8,000
1921		896	14,390	9,353	24,639	128
1922	19,735	1,396	7,387	7,546	36,064	728
1923	(a)	(a)	(a)	(a)	(a)	(a)

[a] Foreign exports for 1923 are recorded as "diamonds and precious stones," 535,840 carats, valued at $27,123.

GOLD AND SILVER

PRODUCTION

Gold and silver produced in the United States, 1919–1923

Year	Gold		Silver	
	Troy ounces	Value	Troy ounces	Commercial value
1919	2,918,628	$60,333,400	56,682,445	$63,533,652
1920	2,476,166	51,186,900	55,361,573	60,801,955
1921	2,422,006	50,067,300	53,052,441	53,052,441
1922	2,363,075	48,849,100	56,240,048	56,240,048
1923	2,502,632	51,734,000	73,335,170	60,134,839

According to tables published by the Director of the Mint the total production of gold and silver in the United States is as follows:

Gold and silver produced in the United States, 1792–1923

[The estimate for 1792–1872 is by R. W. Raymond, commissioner, and for the period since 1872 by the Director of the Mint]

Period	Gold		Silver	
	Troy ounces	Value	Troy ounces	Commercial value
1792–1847	1,186,977	$24,537,000	309,500	$404,500
1848–1872	58,279,781	1,204,750,000	118,568,200	157,749,900
1873–1923	145,813,778	3,014,238,300	2,623,141,555	2,097,107,364
	205,280,536	4,243,525,300	2,742,019,255	2,255,261,764

Gold produced in the United States, 1922 and 1923, by States[a]

State	1922		1923	
	Troy ounces	Value [b]	Troy ounces	Value [b]
Alaska	345,630	$7,144,800	314,960	$6,510,800
Arizona	169,704	3,508,100	296,437	6,127,900
California	712,157	14,721,600	651,369	13,465,000
Colorado	324,456	6,707,100	315,686	6,525,800
Georgia	140	2,900	34	700
Idaho	22,891	473,200	35,764	739,300
Montana	73,443	1,518,200	85,145	1,760,100
Nevada	160,044	3,308,400	198,415	4,101,600
New Mexico	19,553	404,200	23,728	490,500
North Carolina	73	1,500	53	1,100
Oregon	26,728	490,500	23,631	488,500
Pennsylvania	116	2,400	131	2,700
Philippine Islands	73,840	1,526,400	76,137	1,573,900
Porto Rico			5	100
South Carolina	5	100	14	300
South Dakota	320,402	6,623,300	307,012	6,346,500
Tennessee	218	4,500	319	6,600
Texas	19	400	44	900
Utah	107,175	2,215,500	156,991	3,245,300
Virginia	34	700		
Washington	9,394	194,200	16,733	345,900
Wyoming	53	1,100	24	500
	2,363,075	48,849,100	2,502,632	51,734,000

[a] Figures of production issued jointly by the Bureau of the Mint and the Geological Survey.
[b] Gold value, $20.67+ a troy ounce.

Silver produced in the United States, 1922 and 1923, by States[a]

State	1922 (Troy ounces or dollars) [b]	1923	
		Troy ounces	Value [c]
Alaska	770,232	816,177	$669,265
Arizona	4,627,738	7,376,832	6,049,002
California	3,095,480	3,689,856	3,025,682
Colorado	6,018,781	5,529,121	4,533,879
Georgia	394		
Idaho	5,791,413	8,019,977	6,576,381
Illinois	4,612	10,175	8,343
Michigan	360,811	253,705	208,038
Missouri	118,655	167,452	137,311
Montana	9,682,304	14,226,272	11,665,543
Nevada	8,287,704	10,640,656	8,725,338
New Mexico	764,031	737,863	605,048
North Carolina	8	79	65
Oregon	150,347	75,583	61,978
Pennsylvania	2,141	1,278	1,048
Philippine Islands	27,994	39,360	32,275
Porto Rico		184	151
South Dakota	121,427	95,822	78,574
Tennessee	76,885	109,086	89,450
Texas	653,657	825,267	676,719
Utah	15,465,202	20,479,550	16,793,231
Virginia	6		
Washington	219,398	240,712	197,384
Wyoming	828	163	134
	56,240,048	73,335,170	60,134,839

[a] Figures of production issued jointly by the Bureau of the Mint and the Geological Survey.
[b] Valued at $1 an ounce, provided by the Pittman Act of Apr. 23, 1918, for domestic product.
[c] Valued at 82 cents an ounce—average of Pittman Act price ($1 an ounce) January to June and New York price July to December.

IMPORTS AND EXPORTS

Value of gold and silver imported into and exported from the United States, 1919–1923

Year	Gold		Silver	
	Imports	Exports	Imports	Exports
1919	$76,534,046	$368,185,248	$89,410,018	$239,021,051
1920	417,068,273	322,091,208	88,060,041	113,616,224
1921	691,248,297	23,891,377	63,242,671	51,575,399
1922	275,169,785	36,874,894	70,806,653	62,807,286
1923	322,715,812	28,643,417	74,453,530	72,468,789

Value of gold and silver imported into and exported from the United States, 1922 and 1923, by classes

	Imports	Exports	Excess of—	
			Imports	Exports
1922				
Gold:				
Contained in domestic ore and base bullion		$73,709		$73,709
Contained in foreign ore and base bullion	$24,275,253		$24,275,253	
Domestic bullion refined	1,328,408	5,468,225		4,139,817
Foreign bullion refined	180,365,162	81,799	180,283,363	
United States coin	4,868,558	30,323,172		25,454,614
Foreign coin	64,332,404	927,989	63,404,415	
	275,169,785	36,874,894	267,963,031	29,668,140
Excess imports over exports			238,294,891	
Silver:				
Contained in domestic ore and base bullion		17,237		17,237
Contained in foreign ore and base bullion	57,034,500		57,034,500	
Domestic bullion refined		25,060,886		25,060,886
Foreign bullion refined	11,120,413	31,720,047		20,599,634
United States coin	1,249,247	379,792	869,455	
Foreign coin	1,402,493	5,629,324		4,226,831
	70,806,653	62,807,286	57,903,955	49,904,588
Excess imports over exports			7,999,367	
1923				
Gold:				
Contained in domestic ore and base bullion		248,771		248,771
Contained in foreign ore and base bullion	24,048,777		24,048,777	
Domestic bullion refined		19,769,016		19,769,016
Foreign bullion refined	186,123,382	66	186,123,316	
United States coin	37,488,237	7,848,658	29,639,579	
Foreign coin	75,055,416	776,906	74,278,510	
	322,715,812	28,643,417	314,090,182	20,017,787
Excess imports over exports			294,072,395	
Silver:				
Contained in domestic ore and base bullion		45,225		45,225
Contained in foreign ore and base bullion	40,342,858		40,342,858	
Domestic bullion refined		40,127,961		40,127,961
Foreign bullion refined	31,249,574	28,935,369	2,314,205	
United States coin	841,655	214,012	627,643	
Foreign coin	2,019,443	3,146,222		1,126,779
	74,453,530	72,468,789	43,284,706	41,299,965
Excess imports over exports			1,984,741	

PRICES

Gold is valued by law at $20.67+ a troy ounce. For prices of silver, see statement on page 16A.

GRAPHITE

PRODUCTION

Domestic natural graphite sold in the United States, 1919–1923

Year	Amorphous		Crystalline	
	Short tons	Value	Pounds	Value
1919	3,379	$47,716	8,086,191	$731,141
1920	4,694	49,758	9,632,360	576,444
1921	1,842	20,860	1,189,523	75,664
1922	2,200	[a]	1,849,766	85,242
1923	4,056	39,560	3,964,900	151,434

[a] Survey not at liberty to publish value.

Graphite is manufactured by the Acheson Graphite Co. at Niagara Falls, N. Y. The figures given below, published by permission of this company, represent only the manufactured graphite that comes into competition with natural graphite.

Graphite manufactured by the Acheson Graphite Co., 1918–1923, in pounds

1918	9,182,272	1921	5,888,000
1919	8,163,177	1922	13,031,926
1920	7,399,749	1923	26,761,015

IMPORTS AND EXPORTS

Graphite imported for consumption in the United States, 1918–1923

Year	Short tons	Value	Year	Short tons	Value
1918	19,498	$3,092,475	1921	8,183	$452,076
1919	26,626	2,978,096	1922	12,488	473,046
1920	21,095	1,711,312	1923 [a]	19,434	614,119

[a] Composed of the following: "Amorphous" 11,252 tons, $149,831; "crystalline chip or dust" 7,243 tons, $426,417; and "crystalline flake" 939 tons, $37,871. Classes not separately shown for earlier years.

Graphite exported from the United States, 1919–1923

Year	Unmanufactured		Manufactures of
	Pounds	Value	
1919	1,258,040	$90,185	$788,755
1920	1,213,616	112,771	610,261
1921	1,841,578	95,998	679,359
1922	1,138,708	78,094	[a] 255,019
1923	1,815,292	138,542	[a] 335,778

[a] Exclusive of crucibles, figures for which are not available.

PRICES

Prices of best grades of domestic flake graphite (sales at mines) and Ceylon lump (New York prices), in cents per pound, 1918–1923

Year	Domestic flake	Ceylon lump	Year	Domestic flake	Ceylon lump
1918	10–17¾	15¼–28½	1921	4–13	5½–6
1919	5–14	14 –15¼	1922	4– 6	5 –6
1920	6–13	9–14	1923	4– 6⅝	5 –6

GRINDSTONES AND PULPSTONES

[See Abrasive materials]

GYPSUM

PRODUCTION

Gypsum produced and sold in the United States, 1918–1923

Year	Crude produced (short tons)	Crude and calcined sold (total value)	Year	Crude produced (short tons)	Crude and calcined sold (total value)
1918	2,057,015	$11,470,854	1921	2,890,784	$23,700,290
1919	2,420,163	15,727,907	1922	3,779,949	29,361,151
1920	3,129,142	24,533,065	1923	4,753,448	34,888,155

IMPORTS AND EXPORTS

Gypsum imported into the United States comes almost wholly from Nova Scotia and New Brunswick and enters the ports of New England and other North Atlantic States.

Gypsum imported for consumption in the United States, 1919–1923

Year	Unground		Ground or calcined		Value of manufactured plaster of Paris	Keenes cement		Total value
	Short tons	Value	Short tons	Value		Short tons	Value	
1919	171,733	$211,946	10,415	$126,405	$7,719	187	$5,984	$352,054
1920	282,486	397,942	14,921	179,191	10,282	202	5,338	592,753
1921	266,796	364,318	4,495	55,109	33,072	184	6,836	459,335
1922	409,475	523,939	1,774	32,651	55,116	403	9,636	621,342
1923	448,129	629,203	5,133	77,716	41,317	418	11,543	759,779

Exports of gypsum in 1923 were 8,815 short tons, valued at $226,423, compared with 7,673 tons, valued at $178,166, in 1922. Exports are designated as "gypsum or plaster, crude, ground, calcined, and manufactures of." Exports not separately classified for earlier years.

ILMENITE

[See Titanium minerals]

IRON ORE, PIG IRON, AND STEEL

IRON ORE

[Exclusive of all domestic ore containing 5 per cent or more of manganese. For data regarding such ore, see Manganese]

PRODUCTION

Iron ore mined in the United States, 1922 and 1923, by mining districts and varieties, in long tons

District	Hematite	Brown ore	Magnetite	Carbonate	Total
1922					
Lake Superior [a]	39, 693, 966		22, 050		39, 716, 016
Birmingham	4, 429, 170	282, 230			4, 711, 400
Chattanooga	250, 083	122, 121			372, 204
Adirondack			406, 342		406, 342
Northern New Jersey and southeastern New York			113, 629		113, 629
Other districts	[b] 515, 504	[b] 379, 231	910, 945	3, 256	1, 808, 936
	[b] 44, 888, 723	[b] 783, 582	1, 452, 966	3, 256	47, 128, 527
1923					
Lake Superior [a]	59, 196, 734		88, 674		59, 285, 408
Birmingham	5, 740, 233	306, 675			6, 046, 908
Chattanooga	404, 948	229, 102			634, 050
Adirondack			460, 311		460, 311
Northern New Jersey and southeastern New York			376, 495		376, 495
Other districts	[b] 582, 539	[b] 697, 071	1, 265, 144	3, 516	2, 548, 270
	[b] 65, 924, 454	[b] 1, 232, 848	2, 190, 624	3, 516	69, 351, 442

[a] Includes only those mines in Wisconsin which are in the true Lake Superior district.
[b] Some hematite included with brown ore.

Iron ore mined in the United States, 1919–1923, by varieties, in long tons

Year	Hematite	Brown ore	Magnetite	Carbonate	Total
1919	[a] 57, 719, 582	1, 127, 397	[a] 2, 118, 439		60, 965, 418
1920	[a] [b] 63, 883, 523	[b] 1, 325, 661	[a] 2, 391, 541	3, 740	67, 604, 465
1921	[a] [b] 28, 337, 249	[b] 370, 154	[a] 780, 866	2, 709	29, 490, 978
1922	[b] 44, 888, 723	[b] 783, 582	1, 452, 966	3, 256	47, 128, 527
1923	[b] 65, 924, 454	[b] 1, 232, 848	2, 190, 624	3, 516	69, 351, 442

[a] Some magnetite included with hematite. [b] Some hematite included with brown ore.

Iron ore mined in the Lake Superior district, 1919–1923, by ranges, in long tons

Year	Marquette	Menominee	Gogebic	Vermilion	Mesabi	Cuyuna	Total
1919	4, 158, 751	4, 863, 968	7, 368, 994	1, 051, 795	33, 262, 954	1, 685, 877	52, 392, 339
1920	4, 457, 609	5, 651, 542	8, 298, 206	1, 053, 518	36, 641, 880	1, 757, 775	57, 860, 530
1921	2, 204, 114	2, 147, 569	3, 135, 477	981, 576	16, 380, 190	449, 559	25, 298, 485
1922	2, 745, 626	3, 290, 641	4, 910, 789	1, 108, 764	26, 704, 601	955, 595	39, 716, 016
1923	3, 910, 909	4, 913, 541	6, 112, 662	1, 119, 113	41, 809, 018	1, 420, 165	59, 285, 408

Iron ore shipped from mines in the United States, 1918–1923

[Exclusive of ore sold for paint. See p. 71A]

Year	Long tons	Value	Year	Long tons	Value
1918	72, 021, 202	$244, 368, 147	1921	26, 652, 528	$89, 745, 308
1919	56, 372, 784	197, 312, 517	1922	50, 612, 620	157, 809, 286
1920	69, 281, 341	285, 006, 327	1923	69, 811, 472	240, 738, 921

Iron ore shipped from mines in the United States, 1922 and 1923, by States

[Exclusive of ore sold for paint. See p. 71A]

State	1922		1923	
	Long tons	Value	Long tons	Value
Alabama	5,294,520	$8,791,069	6,922,663	$15,540,198
California	3,204	18,868	2,769	18,665
Colorado	513	[a]	4,102	[a]
Georgia	28,566	77,636	117,286	300,712
Idaho	25	[a]	1,290	[a]
Massachusetts	4,368	[a]		
Michigan	12,457,856	43,449,513	14,065,561	54,110,070
Minnesota	30,209,372	98,903,398	44,556,053	158,402,788
Missouri	58,320	244,928	54,348	247,975
Montana	21,726	59,566	17,751	51,039
Nevada	25	[a]	9,578	[a]
New Jersey	90,374	400,356	349,435	1,403,723
New Mexico	118,038	[a]	205,218	[a]
New York	191,195	1,049,050	722,096	3,242,229
North Carolina	19,279	49,415	59,684	161,603
Pennsylvania	782,916	1,022,756	988,586	2,264,485
Tennessee	159,473	418,578	266,175	677,753
Utah	15,018	63,806	57,752	205,936
Virginia	30,359	120,685	200,966	664,240
Wisconsin	794,673	2,455,660	831,412	2,421,194
Wyoming	332,800	[a]	378,747	[a]
Undistributed		[b] 684,002		[b] 1,026,311
	50,612,620	157,809,286	69,811,472	240,738,921

[a] Included under "Undistributed."
[b] This figure includes value for States entered as "(a)" above.

STOCKS

Stocks of iron ore at mines in the United States, December 31, 1922 and 1923, in long tons

State	1922	1923	State	1922	1923
Alabama	443,779	304,262	New Jersey	204,080	145,595
Georgia	120	155	New York	683,223	498,901
Idaho	175		Pennsylvania	3,069	4,408
Iowa	12,165	12,165	Virginia	62,441	10,022
Michigan	6,061,403	6,279,090	Wisconsin	297,628	256,319
Minnesota	2,750,916	2,651,879			
Missouri	5,280	3,079		10,524,279	10,165,875

IMPORTS AND EXPORTS

Iron ore imported into and exported from the United States, 1919–1923

Year	Imports		Exports	
	Long tons	Value	Long tons	Value
1919	476,461	$2,385,689	996,569	$4,308,746
1920	1,273,456	4,963,654	1,145,037	6,198,927
1921	315,768	1,075,909	440,106	2,077,620
1922	1,135,156	4,916,294	602,194	2,770,878
1923	2,768,399	11,304,737	1,116,932	5,305,365

PRICES

Average value of iron ore per long ton at the mine in the United States, 1919–1923

Year	Hematite	Brown ore	Magnetite	Carbonate	General average
1919	$3.48	$3.63	$4.08		$3.50
1920	4.09	4.19	4.59	[a]	4.11
1921	3.37	2.63	3.61	[a]	3.37
1922	3.14	2.65	2.37	[a]	3.12
1923	3.46	2.88	3.34	[a]	3.45

[a] Sold for paint and not included in shipments of iron ore.

Selling prices of iron ore per long ton at lower Lake ports at date of buying movement, 1919–1923 [a]

Season	Date of buying movement	Season iron-ore prices			
		Old range Bessemer	Mesabi Bessemer	Old range non-Bessemer	Mesabi non-Bessemer
1919	Apr. 28, 1919	$6.45	$6.20	$5.70	$5.55
1920	Feb. 2, 1920	7.45	7.20	6.70	6.55
1921	June 16, 1921	6.45	6.20	5.70	5.55
1922	June 9, 1922	5.95	5.70	5.20	5.05
1923	Mar. 24, 1923	6.45	6.20	5.70	5.55

[a] Iron Trade Review.

PIG IRON

PRODUCTION

Pig iron shipped from blast furnaces in the United States, 1918–1923

Year	Long tons	Value	Year	Long tons	Value
1918	38,230,440	$1,180,759,565	1921	16,038,619	$389,437,792
1919	30,130,231	775,915,043	1922	27,670,738	608,144,858
1920	35,710,227	1,140,904,096	1923	38,361,379	946,799,378

Pig iron shipped from blast furnaces in the United States, 1922 and 1923, by States

State	1922		1923	
	Long tons	Value	Long tons	Value
Alabama	2,223,159	$42,883,424	2,784,625	$64,912,809
Colorado	[a]	[a]	[a]	[a]
Connecticut	[a]	[a]		
Illinois	2,729,172	58,954,675	3,741,002	94,878,917
Indiana	2,191,356	43,064,817	3,021,504	70,270,894
Kentucky	140,217	2,951,627	154,680	[a]
Maryland	423,533	[a]	489,137	[a]
Massachusetts	510	[a]	1,667	[a]
Michigan	595,647	14,791,041	717,279	18,827,808
Minnesota	177,297	[a]	418,726	[a]
Missouri	7,700	[a]	4,513	[a]
New Jersey	88,908	[a]	[a]	[a]
New York	1,708,605	37,783,073	2,426,522	57,543,779
Ohio	6,756,648	149,805,909	8,964,805	222,009,553
Pennsylvania	9,732,024	221,581,288	13,898,624	347,679,274
Tennessee	95,326	2,063,376	215,009	5,793,756
Virginia	31,022	793,903	238,742	6,389,149
West Virginia	309,944	7,537,184	506,543	12,499,112
Wisconsin	209,289	4,970,227	280,457	7,264,981
Undistributed	[b] 250,381	[b] 20,964,314	[b] 497,544	[b] 38,729,346
	27,670,738	608,144,858	38,361,379	946,799,378

[a] Included under "Undistributed."

[b] This figure covers States entered as "(a)" above.

IMPORTS AND EXPORTS

Pig iron, including kentledge, ferromanganese, ferrosilicon, and spiegeleisen, 1918–1921, and pig iron, 1922 and 1923, imported into the United States [a]

Year	Long tons	Value	Year	Long tons	Value
1918	34,711	$4,968,056	1921	44,036	$2,014,926
1919	101,665	6,565,106	1922	383,445	8,670,860
1920	185,944	12,801,834	1923	367,778	9,005,077

[a] Separate figures for pig iron not available prior to 1922.

Pig iron [a] *exported from the United States, 1918–1923*

Year	Long tons	Value	Year	Long tons	Value
1918	269,575	$11,576,721	1921	28,307	$933,093
1919	321,261	12,313,183	1922	30,920	756,842
1920	216,828	10,074,377	1923	32,318	862,443

[a] Figures for years prior to 1922 include ferroalloys. Separate data not available.

PRICES

Average monthly prices per ton of principal grades of pig iron in the United States, 1922 and 1923 [a]

Month	1922				1923			
	Foundry pig iron at Valley furnaces	Foundry pig iron at Birmingham, Ala., furnaces	Bessemer pig iron at Valley furnaces	Basic pig iron at Valley furnaces	Foundry pig iron at Valley furnaces	Foundry pig iron at Birmingham, Ala., furnaces	Bessemer pig iron at Valley furnaces	Basic pig iron at Valley furnaces
January	$19.38	$15.96	$19.62	$18.19	$27.00	$23.23	$27.50	$25.00
February	18.92	15.33	19.40	18.00	27.21	24.29	27.75	25.67
March	18.87	15.31	19.02	17.89	30.00	26.33	29.94	29.44
April	20.74	15.74	20.88	19.98	31.00	27.00	31.00	31.00
May	24.00	17.63	25.08	24.62	30.69	27.00	30.23	29.33
June	24.00	18.44	25.00	25.00	28.04	25.63	28.73	26.85
July	24.20	18.56	25.00	24.32	25.70	25.00	26.82	25.12
August	29.04	20.37	27.74	26.17	25.00	23.37	26.50	25.00
September	35.02	25.40	33.76	30.08	24.96	22.81	26.50	24.92
October	31.63	27.04	33.23	30.23	23.76	20.11	25.33	24.00
November	28.78	24.12	31.70	28.28	21.84	19.04	23.82	21.20
December	25.92	22.70	27.78	24.96	21.96	20.36	23.00	20.96
Average	25.04	19.72	25.68	23.98	26.43	23.68	27.26	25.71

[a] Metal Statistics.

STEEL

Steel produced in the United States, 1919–1923, in long tons [a]

Year	Bessemer	Open hearth	Crucible	Other steel	Total
1919	7,271,562	26,948,694	63,572	387,404	34,671,232
1920	8,883,087	32,671,895	72,265	505,687	42,132,934
1921	4,015,938	15,589,802	7,613	170,444	19,783,797
1922	5,919,298	29,308,983	28,606	346,039	35,602,926
1923	8,484,088	35,899,657	44,079	515,872	44,943,696

[a] According to the American Iron and Steel Institute.

LEAD

SUPPLY

Apparent consumption of refined primary lead in the United States (refinery stocks disregarded), 1919–1923, in short tons

	1919	1920	1921	1922	1923
Supply:					
Stock in bonded warehouses Jan. 1	472	234	1,322	347	
Imports of pigs, bars, and old	5,107	35,719	31,301	3,551	21,099
Production	482,220	529,657	448,589	532,662	618,322
	487,799	565,610	481,212	536,560	639,421
Withdrawn:					
Exports of foreign lead—					
From warehouse	40,976	17,363	25,000	32,355	48,736
In manufactures, with benefit of drawback	1,936	6,175	9,369	5,677	12,525
Exports of domestic lead	10,510	2,730	1,624	5,823	1,999
Stock in bonded warehouses Dec. 31	234	1,322	347		2,617
	53,656	27,590	36,340	43,855	65,878
Apparent consumption	434,143	538,020	444,872	492,705	573,543

PRODUCTION

Refined primary lead produced in the United States from domestic ores, 1918–1923

Year	Short tons	Value	Year	Short tons	Value
1918	539,905	$76,667,000	1921	398,222	$35,840,000
1919	424,433	44,990,000	1922	468,746	51,562,000
1920	476,849	76,296,000	1923	543,841	76,138,000

Refined primary lead produced in the United States, 1919–1923, in short tons

	1919	1920	1921	1922	1923
Domestic ore:					
Desilverized lead	208,751	220,327	187,962	185,191	291,760
Soft lead	147,744	189,854	157,513	209,250	190,749
Desilverized soft lead	67,938	66,668	52,747	74,305	61,332
Total from domestic ore	424,433	476,849	398,222	468,746	543,841
Foreign ore:					
Africa	644	1,171			99
Australia	69	470			
Canada	1,895	1,186	2,877	3,604	3,632
Central America	12	22	6	14	18
Mexico	2,261	2,729	1,912	7,260	18,867
South America	2,537	2,747	2,235	2,458	1,461
Other foreign	238	109	90	562	211
Foreign base bullion:					
Canada	567	1,919	1,599	2,900	
Mexico	49,564	42,421	41,648	47,118	50,193
South America		54			
Total from foreign ore and base bullion	57,787	52,808	50,367	63,916	74,481
Grand total from all sources	482,220	529,657	448,589	532,662	618,322
Production of antimonial lead	13,874	12,535	10,064	8,075	14,190

Secondary lead recovered in the United States, 1919–1923, in short tons

	1919	1920	1921	1922	1923
Pig lead	55,684	56,350	46,370	75,480	96,430
Lead in alloys	66,416	68,300	57,410	84,080	98,060
Total recovered lead	122,100	124,650	103,780	159,560	194,490

IMPORTS AND EXPORTS

Lead imported into the United States in ore, base bullion, and refined, by sources, 1919–1923, in pounds

[General imports]

Year	Canada	Mexico	South America	Europe	Other countries	Total imports
1919	10,391,115	125,541,614	5,504,416	89,840	286,142	141,813,127
1920	8,199,234	131,815,278	7,085,351	38,766,504	11,163,160	197,029,527
1921	8,127,158	106,406,238	2,381,365	30,224,701	1,430,949	148,570,411
1922	8,663,236	141,216,136	3,803,478	1,454,384	513,335	155,650,569
1923	11,399,671	242,352,788	5,300,161	11,004,938	520,635	270,578,193

Lead imported into the United States, by classes, 1919–1923, in pounds

[General imports]

Year	Lead in ore (lead content)	Base bullion		Pigs, bars, sheets, and old	Total lead content
		Gross weight	Lead content		
1919	19,573,856	115,317,160	112,024,518	10,214,753	141,813,127
1920	29,488,816	101,476,550	96,103,603	71,437,108	197,029,527
1921	14,234,039	77,882,834	71,733,838	62,602,534	148,570,411
1922	24,474,481	[a]	124,074,465	7,101,623	155,650,569
1923	66,882,850	[a]	161,496,495	42,198,848	270,578,193

[a] Figures not available.

Lead imported for consumption in the United States, 1919–1923, by classes

Year	Lead in ore [a]		Base bullion		Pigs, bars, and old [b]		Sheets, pipe, and shot		Not otherwise specified (value)	Total value
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value		
1919	4,106,823	$196,363	31,796,693	$1,130,937	10,174,115	$415,094	8,018	$628	$17,187	$1,760,209
1920	13,700,499	908,619	66,816,820	3,340,600	68,901,959	3,887,821	81,396	5,483	21,328	8,163,851
1921	6,842,807	327,046	56,819,980	1,668,410	61,909,094	1,972,716	3,087	140	11,204	3,979,516
1922	23,649,851	812,603	55,859,422	1,815,142	8,563,110	335,924	6,018	697	12,286	2,976,652
1923	22,420,046	1,190,414	11,124,151	626,201	42,925,265	2,510,466	19,525	4,495	90,027	4,421,603

[a] Includes also lead in matte beginning Sept. 22, 1922, when new tariff went into effect.
[b] Includes also imports of antimonial lead, antimonial scrap lead, babbitt metal, solder, etc., beginning Sept. 22, 1922, when new tariff went into effect.

Lead exported from the United States, 1919–1923, by classes

Year	Pigs and bars				Foreign lead used in articles exported with benefit of drawback [a]	Manufactures of lead from both domestic and foreign ores
	From domestic ore		From foreign ore			
	Pounds	Value	Pounds	Value	Pounds	
1919	21,019,605	$1,471,256	81,951,396	$4,536,273	3,872,130	$2,155,436
1920	5,459,713	462,223	34,725,501	2,570,535	12,350,794	3,621,397
1921	3,247,294	177,926	50,000,259	2,284,107	18,738,927	1,376,259
1922	11,645,821	604,605	64,709,305	3,177,360	11,354,070	1,158,150
1923	3,997,485	260,487	97,471,326	5,195,256	25,052,107	1,078,636

[a] Exclusive of lead that entered as pig and was exported in the same form, which would be duplicated in exports of lead from foreign ore. Value not available after 1920.

Pig lead exported from the United States, 1921–1923, by destination, in short tons

Destination	1921		1922		1923	
	Domestic	Foreign	Domestic	Foreign	Domestic	Foreign
Canada	170	40	337	150	126	1
Great Britain	3	13,154	1,374	8,281	185	21,248
Netherlands	118	1,401	1	1,681	112	4,348
France	616	224	1,737	10,678	336	10,335
Japan	28	4,200	246	56	112	
Other countries	689	5,981	2,128	11,509	1,128	12,804
	1,624	25,000	5,823	32,355	1,999	48,736

PRICES

[See statement on p. 16A]

LIME

PRODUCTION

Lime sold by the producers in the United States, 1919–1923

Year	Short tons	Value [a]	Number of plants in operation
1919	3,330,347	$29,448,553	539
1920	3,570,141	37,543,840	515
1921	2,532,153	24,895,370	520
1922	3,639,617	33,255,039	530
1923	4,076,243	39,993,652	467

[a] The value given represents the value of bulk lime f. o. b. at point of shipment and does not include cost of barrel or packag[illegible]

Hydrated lime sold by the producers in the United States, 1919–1923

Year	Short tons	Value	Number of plants in operation
1919	777,403	$7,061,146	93
1920	853,116	9,287,562	98
1921	792,970	7,421,637	105
1922	1,106,063	9,868,980	114
1923	1,225,928	12,229,598	121

Lime sold by the producers in the United States, 1922 and 1923, by States

State	1922			1923		
	Number of plants in operation	Short tons	Value	Number of plants in operation	Short tons	Value
Alabama	11	168,135	$979,331	12	193,429	$1,627,539
Arizona	2	(a)	(a)	3	18,764	264,683
Arkansas	5	11,951	115,008	3	14,941	136,185
California	8	55,161	682,774	8	66,703	869,979
Colorado	4	(a)	(a)	3	(a)	(a)
Connecticut	6	52,108	743,742	6	59,158	813,254
Florida	3	(a)	(a)	2	(a)	(a)
Georgia	1	(a)	(a)	1	(a)	(a)
Hawaii	1	(a)	(a)	1	(a)	(a)
Idaho	2	(a)	(a)	2	(a)	(a)
Illinois	10	85,125	860,945	11	92,633	978,658
Indiana	8	113,246	938,645	7	126,296	1,161,083
Iowa	2	(a)	(a)	2	(a)	(a)
Kentucky	3	1,560	11,062	1	(a)	(a)
Maine	4	127,840	1,757,480	4	134,781	1,946,486
Maryland	21	71,261	554,194	14	69,858	553,811
Massachusetts	10	164,980	2,510,368	10	180,720	2,550,575
Michigan	7	53,635	484,945	7	59,629	612,369
Minnesota	5	27,670	307,270	4	29,895	339,957
Missouri	16	203,984	1,953,524	16	246,326	2,505,785
Montana	2	(a)	(a)	2	(a)	(a)
Nevada	1	(a)	(a)	1	(a)	(a)
New Jersey	4	2,392	20,845	2	(a)	(a)
New Mexico	4	3,587	38,520	3	1,859	15,362
New York	16	96,320	957,079	15	109,862	1,057,737
North Carolina	1	(a)	(a)	1	(a)	(a)
Ohio	29	752,916	6,495,066	31	867,922	8,740,688
Oklahoma	2	(a)	(a)	2	(a)	(a)
Oregon	2	(a)	(a)	1	(a)	(a)
Pennsylvania	177	719,536	5,581,764	143	772,839	6,372,732
Porto Rico	27	5,822	67,636	24	6,167	71,014
Rhode Island	1	(a)	(a)	1	(a)	(a)
South Dakota	3	3,852	43,960	2	(a)	(a)
Tennessee	15	126,305	939,039	16	131,995	1,028,158
Texas	7	52,552	524,985	9	62,822	606,976
Utah	13	11,082	147,087	11	12,228	152,136
Vermont	9	44,745	505,498	10	58,681	702,588
Virginia	41	152,436	1,251,683	32	182,604	1,490,806
Washington	6	25,447	355,412	6	25,895	376,510
West Virginia	15	215,146	1,643,055	11	241,601	2,029,961
Wisconsin	24	189,558	1,569,931	25	227,349	2,055,646
Wyoming	2	(a)	(a)	1	(a)	(a)
Undistributed	----------	96,965	1,133,131	----------	91,116	977,374
	530	3,639,617	33,255,039	467	4,076,243	39,993,652

(a) Included under "Undistributed."

IMPORTS AND EXPORTS

Lime imported for consumption in the United States, 1918–1923

Year	Short tons	Value	Year	Short tons	Value
1918	6,650	$73,148	1921	10,811	$234,798
1919	8,679	128,510	1922	14,112	266,845
1920	22,088	392,137	1923	25,407	428,903

Lime exported from the United States, 1918–1923

Year	Short tons	Value	Year	Short tons	Value
1918	7,191	$105,803	1921	5,192	$109,769
1919	6,372	108,370	1922	8,389	116,649
1920	5,921	128,296	1923	11,789	170,289

LITHIUM MINERALS

Lithium minerals produced in the United States, 1918–1923

Year	Short tons	Value	Year	Short tons	Value
1918	5,264	$111,600	1921	1,823	$33,508
1919	6,287	115,000	1922	2,172	41,300
1920	11,696	173,602	1923	2,310	38,800

Imports and exports of lithium minerals are not reported separately.

LITHOGRAPHIC STONE

During 1913 and 1914 small quantities of lithographic stone were quarried at Brandenburg, Meade County, Ky. No domestic production was reported for 1915 nor has any been reported since 1918.

Lithographic stone produced in the United States, 1916–1918

Year	Pounds	Value
1916	40,000	$1,500
1917	5,832	489
1918	6,000	350

Lithographic stone imported for consumption in the United States, 1918–1923

Year	Pounds	Value	Year	Pounds	Value
1918			1921	301,546	$34,101
1919	464,914	$216,293	1922	253,426	28,242
1920	786,119	63,733	1923	225,600	24,861

No exports of lithographic stone are reported.

MAGNESITE

PRODUCTION

Crude domestic magnesite sold or treated in the United States, 1919–1923

Year	California		Washington		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1919	50,020	$504,973	106,206	$743,442	156,226	$1,248,415
1920	81,782	1,083,262	221,985	1,664,888	303,767	2,748,150
1921	47,904	510,177			47,904	510,177
1922	[a] 55,790	[a] 571,745	(a)	(a)	55,790	571,745
1923	73,350	938,600	73,900	165,100	147,250	1,103,700

[a] Washington included with California. Survey not at liberty to publish figures.

IMPORTS

Magnesite (not purified) imported for consumption in the United States, 1921–1923

	1921		1922		1923	
	Short tons	Value	Short tons	Value	Short tons	Value
Caustic calcined	6,788	$250,932	42,065	$802,025	11,229	$315,585
Dead-burned	(a)	(a)	a 30,200	a 465,597	61,726	707,383
Crude	51,993	525,452	73,331	976,283	5,182	44,081

a Not separately classified prior to Sept. 22, 1922, when new tariff went into effect.

Exports are not separately recorded.

MAGNESIUM

PRODUCTION

Domestic metallic magnesium sold or used in the United States, 1919–1923

Year	Number of producers	Pounds	Value		
			Total	Average per pound	
				Ingot (stick)	Powder
1919	3	127,465	$247,302	$1.83	$2.85
1920	2	(a)	(a)	1.60	2.75
1921	1	48,000	86,000	1.30	2.36
1922	2	b 60,000	b 89,000	1.60	1.13
1923	2	b 125,000	b 155,000	1.25	1.00

a Survey not at liberty to publish figures.
b Estimate.

IMPORTS

Magnesium imported for consumption in the United States, 1918–1923

Year	Pounds	Value	Year	Pounds	Value
1918—July to December a	11,899	$16,259	1921	39,913	$30,592
1919	13,239	13,583	1922	182,939	54,448
1920	29,275	25,055	1923	13,974	11,576

a Prior to 1915 the entire domestic supply was imported, but such imports are not separately shown until July, 1918.

Exports are not separately recorded.

MANGANESE

SUPPLY

Manganese alloys and ore produced in the United States and imported from principal foreign sources, 1919–1923, in long tons

Year	Steel	Ferromanganese		Spiegeleisen		Manganese ore				
	Production [a]	Shipments	Imports	Shipments	Imports	Shipments [b]	Total imports	Imports from—		
								Russia	India	Brazil
1919	34,671,232	198,255	33,022	90,855	27	54,957	333,344	6,916	9,200	246,592
1920	42,132,934	276,594	59,254	103,672	5,234	94,420	[c]599,764	18,762	71,238	421,523
1921	19,783,797	111,374	9,077	69,230	307	13,531	[c]392,606		113,730	262,468
1922	35,602,926	161,612	[d]100,725	70,253	[d]25,159	13,404	[d]425,000	[f]1,642	[f]298	[f]40,595
									[e]24,250	[e]234,598
1923	44,943,696	226,365	[d]113,833	134,086	[d]23,340	31,500	[d]419,000	[e]11,670	[e]25,568	[e]88,036

[a] According to American Iron and Steel Institute.
[b] Exclusive of small quantities of ore shipped for use in fluxing.
[c] Exclusive of 7,173 tons in 1920 and 8,748 tons in 1921 reported by Bureau of Foreign and Domestic Commerce as manganese ore. The value of this "ore" ranged from $46 to $292 a ton; consequently the Survey believes that the figures represent imports of ferromanganese, spiegeleisen, manganese chemicals, and perhaps some chemical ore.
[d] Prior to Sept. 22, 1922, the Bureau of Foreign and Domestic Commerce reported the gross weight of manganese ore, ferromanganese, and spiegeleisen imported, but since that date has reported only the manganese content. This figure is a Survey estimate of the gross weight of ore or alloy imported. For the figures reported by the Bureau of Foreign and Domestic Commerce, see the tables on pages 48A and 69A.
[e] For Jan. 1 to Sept. 21, 1922. Figures represent gross weight of manganese ore imported.
[f] For Sept. 22 to Dec. 31, 1922. Figures represent manganese content of ore imported.
[g] Figures represent manganese content of ore imported.

PRODUCTION

Manganese and manganiferous ore (exclusive of fluxing ore) shipped from mines in the United States, 1919–1923

State	Ore containing 35 per cent of manganese or more			Ore containing 10 to 35 per cent of manganese			Ore containing 5 to 10 per cent of manganese		
	Number of shippers	Long tons	Value	Number of shippers	Long tons	Value	Number of shippers	Long tons	Value
1922									
Alabama				1	475	$1,900			
Arizona	2	203	$2,572						
Arkansas	9	2,264	42,197						
California	1	[a]	[a]						
Georgia				1	839	[a]	1	194	[a] [*]
Michigan				2	9,644	[a]			
Minnesota				3	305,093	940,311	4	248,560	$622,278
Montana	3	9,751	371,245						
Nevada	1	[a]	[a]						
New Mexico				2	28,623	[a]			
Tennessee	1	113	1,636						
Virginia	1	800	[a]						
Wisconsin							1	2,860	[a]
Undistributed		273	37,510			129,569			9,761
Total, 1922	18	13,404	455,160	9	344,674	1,071,780	6	251,614	632,039
Total, 1921	14	13,531	495,097	6	8,439	42,755	3	62,670	147,576
Total, 1920	56	94,420	2,396,235	31	357,279	1,450,518	6	279,687	644,572
Total, 1919	42	54,957	1,791,118	24	211,632	965,660	9	112,303	352,570
1923									
Alabama	1	[a]	[a]	4	694	8,067			
Arizona	1	245	[a]						
Arkansas	8	3,768	73,507	7	4,773	20,047			
California	2	[a]	[a]						
Colorado	3	2,278	41,203	8	18,348	68,204			
Georgia	5	1,502	23,380	11	14,718	80,135	7	15,530	43,711
Michigan				1	20,079	80,517	1	204,700	[a]
Minnesota				4	253,634	880,575	3	499,181	1,406,385
Montana	6	21,916	674,509						
New Mexico	3	179	3,693	3	6,759	17,398			
Oklahoma	1	[a]	[a]						
Tennessee	3	213	5,611						
Virginia	3	987	42,020	3	661	3,685			
Wisconsin							1	353,046	[a]
Undistributed		412	11,050						2,148,231
Total, 1923	36	31,500	874,973	41	319,666	1,158,628	12	1,072,457	3,598,327

[*] Included under "Undistributed." Geological Survey not at liberty to publish.

Manganese and manganiferous ore (for fluxing purposes) shipped from mines in the United States, 1919–1923

Year	Ore containing 35 per cent of manganese or more		Ore containing 10 to 35 per cent of manganese		Ore containing 5 to 10 per cent of manganese [a]	
	Long tons	Value	Long tons	Value	Long tons	Value
1919	365	$5,745	98,202	$216,868	11,596	$17,394
1920			123,970	332,615	6,728	10,093
1921			22,962	[b] 57,000	3,028	[b] 7,800
1922	2,278	17,341	27,705	[b] 52,000	1,666	[b] 10,600
1923	769	[c]	40,770	[c] 134,133	1,004	[b] 2,510

[a] Includes small quantities of ore containing less than 5 per cent of manganese. For such figures see p. 151.
[b] Partly estimated.
[c] Value for 35 per cent ore included with that for 10–35 per cent ore. Survey not at liberty to publish figures.

Manganiferous silver ore shipped from mines in the United States, 1919–1923, in long tons

Year	Arizona	Colorado	Montana	Nevada	New Mexico
1919	1,964	40,824		77,815	250
1920	345	45,726		95,142	541
1921		11,743		14,871	300
1922		13,951	6,656		8,764
1923		28,724	3,596	28,571	

Manganiferous iron ore shipped from the Cuyuna district, Minn., 1918–1923, in long tons

Year	Ore containing 10 to 35 per cent of manganese	Ore containing 5 to 10 per cent of manganese	Year	Ore containing 10 to 35 per cent of manganese	Ore containing 5 to 10 per cent of manganese
1918	625,009	227,202	1921		56,530
1919	138,952	98,220	1922	305,093	248,560
1920	293,524	248,913	1923	253,634	499,181

IMPORTS

Manganese ore [a] imported for consumption in the United States, 1918–1923

Year	Long tons	Value	Year	Long tons	Value
1918	491,303	$15,095,867	1922 [c] Jan. 1–Sept. 21	327,727	$2,695,724
1919	333,344	11,229,184	1922 [c] Sept. 22–Dec. 31	[c] 18,124	364,247
1920 [b]	606,937	12,230,922	1923	[c] 78,391	1,674,914
1921 [b]	401,354	3,365,732			

[a] Prior to Sept. 22, 1922, figures represent ore; beginning with new tariff, figures represent manganese content of ore.
[b] Includes 7,173 tons, valued at $428,047, in 1920, and 8,748 tons, valued at $501,633, in 1921, reported by Bureau of Foreign and Domestic Commerce as manganese ore. The value of this "ore" ranged from $46 to $292 a ton, consequently the Survey believes that the figures represent imports of ferromanganese, spiegeleisen, manganese chemicals, and perhaps some chemical ore.
[c] Includes estimate by Survey for manganese content of ore imported from Cuba. The Bureau of Foreign and Domestic Commerce records only gross weight of Cuban ore imported, and the figures for such ore have been as follows: 1922 (Sept. 22 to Dec. 31), 190 long tons; 1923, 9,062 tons.

Manganese ore imported into the United States, 1922 and 1923, by countries

[General imports]

Country	1922				1923	
	Jan. 1–Sept. 21		Sept. 22–Dec. 31			
	Ore (long tons)	Value	Manganese content (long tons)	Value	Manganese content (long tons)	Value
Africa (British):						
South	5,998	$21,891				
West	22,701	106,223			27,965	$297,376
Argentina					928	20,040
Belgium			528	$18,956		
Brazil	234,598	2,025,505	40,595	469,938	88,036	1,454,790
Canada	60	2,208	67	3,619		
Chile					789	16,772
China	2	46	1	67	1	55
Cuba	12,568	89,677			(a)	137,016
England	448	18,242	1,093	74,429	287	36,375
Germany	41	3,259	52	5,131	146	14,654
Hongkong			1,243	28,677	20	1,020
India (British)	24,250	82,016	298	4,793	25,568	625,299
Java and Madura			205	10,250	6	369
Mexico	500	10,000				
Netherlands					26	1,664
Oceania (French)					(b)	36
Panama	(b)	19			400	5,300
Russia in Europe			1,642	38,180	11,670	262,790
Turkey:						
In Asia					3,005	86,798
In Europe	26,561	336,638	1,000	50,000	38,139	914,156
	327,727	2,695,724	46,724	704,040	c 196,986	3,874,510

a The imports from Cuba are recorded as 9,062 long tons of ore in 1923; manganese content not shown.
b Less than 1 ton.
c Exclusive of the manganese content of Cuban ores.

No separate record of exports of manganese ore is kept.

MANGANIFEROUS ZINC RESIDUUM

Manganiferous zinc residuum containing 12 to 15 per cent of manganese and 40 per cent of iron is recovered from roasted franklinite concentrates at Franklin Furnace, N. J. No price is given for this material, as it is not sold in the open market, but is reduced to spiegeleisen by the company that produces it.

Manganiferous residuum, from zinc roasting in the United States, shipped in 1918–1923, in long tons

1918	146,796	1921	12,627
1919	80,418	1922	81,333
1920	133,602	1923	132,801

MARLS

Calcareous marl sold by producers in the United States, 1918–1923

Year	Short tons	Value	Year	Short tons	Value
1918	98,694	$261,082	1921	59,730	$195,743
1919	91,437	327,294	1922	67,777	203,196
1920	97,487	322,339	1923	99,410	328,932

Greensand marl is produced in New Jersey. The quantity mined in 1923 was 10,656 short tons, valued at $131,123, compared with 7,885 tons, valued at $56,800, in 1922, and 2,058 tons, valued at $10,200, in 1921.

No imports or exports of marl are reported.

MICA

PRODUCTION

Mica sold by the producers in the United States, 1919–1923

Year	Sheet mica [a]		Scrap mica		Total	
	Pounds	Value	Short tons	Value	Short tons	Value
1919	[a] 1,545,709	[a] $483,567	3,258	$58,084	[a] 4,031	[a] $541,651
1920	1,683,480	546,972	5,723	167,017	6,565	713,989
1921	741,845	118,513	2,577	56,849	2,948	175,362
1922	1,077,968	194,301	[b] 6,641	114,045	[b] 7,180	308,346
1923	2,063,179	311,180	[b] 8,054	129,695	[b] 9,086	440,875

[a] The figures for sheet mica in 1920–1923 are not strictly comparable with those for earlier years, as they represent uncut sheet mica exclusively. Prior to 1920 some cut sheet mica was included—the cutting having the twofold effect of reducing the quantity and of increasing the value.
[b] Includes mica derived from mica schist.

IMPORTS AND EXPORTS

Mica imported for consumption in the United States, 1919–1923

Year	Sheet				Ground		Total	
	Unmanufactured		Cut and splittings					
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
1919	723,713	$726,532	[a]	$762,228	62	$9	[a]	$1,488,769
1920	1,298,537	1,177,943	[a]	2,011,434			[a]	3,189,377
1921	328,444	331,219	[a]	758,521	134,650	2,166	[a]	1,091,906
1922	385,653	359,793	[a]	[b] 966,315	313,745	4,514	[a]	1,330,622
1923	1,044,366	532,375	[c] 4,419,102	[c] 1,844,149	1,867,385	28,324	7,330,853	2,404,848

[a] Quantity not reported.
[b] Includes also value of "built up, washers, and other manufactures" ($20,899) imported Sept. 22 to Dec. 31. Not separately classified prior to new tariff.
[c] Composed of following: "Cut mica" 60,135 pounds, $49,268; "splittings" 4,301,727 pounds, $1,730,532; "built up" 30,032 pounds, $37,382; and "washers and other" 27,208 pounds, $26,967.

Value of mica exported from the United States, 1918–1923

1918	$74,529	1921	$153,990
1919	109,348	1922	129,186
1920	316,169	1923	182,162

MILLSTONES

[See Abrasive materials]

MINERAL PAINTS

Domestic zinc and lead pigments,[a] made directly from ores in the United States, sold in 1918–1923

Year	Short tons	Value	Year	Short tons	Value
1918	135,746	$26,464,590	1921	102,463	$14,801,032
1919	155,648	25,810,671	1922	162,815	22,205,400
1920	143,244	24,564,572	1923	163,240	23,660,381

[a] Include sublimed blue lead, sublimed white lead, leaded zinc oxide, and zinc oxide.

The canvass of natural mineral pigments was discontinued after 1915. Iron ore sold for paint in 1918–1923 is shown below.

Iron ore sold by producers for paint in the United States, 1918–1923

Year	Short tons	Value	Year	Short tons	Value
1918	10,034	$22,924	1921	11,624	$56,824
1919	17,885	84,630	1922	30,668	166,682
1920	27,382	112,364	1923	27,823	140,306

MINERAL WATERS

PRODUCTION

Domestic mineral waters sold by the producers in the United States, 1919–1923

Year	Gallons	Value
1919	38,697,280	$4,880,186
1920	36,218,260	4,860,915
1921	34,781,238	4,876,445
1922	38,492,881	5,498,269
1923	44,430,998	6,493,177

IMPORTS AND EXPORTS

Mineral waters imported for consumption in the United States, 1919–1923

Year		Gallons	Value
1919	Natural	193,933	$112,732
	Artificial	9,081	4,216
1920	Natural	466,547	177,992
	Artificial	60,567	25,909
1921	Natural	498,090	156,297
	Artificial	26,675	10,804
1922	Natural[a] (Jan. 1–Sept. 21)	430,135	148,731
	Artificial[a] (Jan. 1–Sept. 21)	26,223	10,547
	Natural and artificial (Sept. 22–Dec. 31)	242,393	109,967
1923	Natural and artificial	722,657	279,875

[a] Not separately shown after Sept. 21, 1922.

Large quantities of a few domestic waters are exported, but no figures are available prior to 1922, when 209,219 gallons of natural and artificial mineral waters, valued at $169,473, were exported. Similar exports in 1923 were 227,831 gallons, valued at $193,248.

MOLYBDENUM

PRODUCTION

Molybdenum ores were produced in the United States by one company only, at Questa, N. Mex., in 1923. Other mines have remained closed for lack of market.

Molybdenum in ore and concentrates, produced in the United States, sold in 1918–1923

Year	Pounds	Value
1918	861,637	$1,253,700
1919	297,926	341,814
1920	34,900	17,207
1921		
1922		
1923	22,667	(a)

[a] Survey not at liberty to publish figures.

IMPORTS

"Molybdenum ore[a] (steel-hardening)" imported for consumption in the United States, 1918–1923

Year	Pounds	Value	Year	Pounds	Value
1918—July to December [b]	[c] 140,222	$123,924	1921	[c] 29,783	$20,471
1919	[c] 106,743	77,572	1922	[c] 412,221	90,015
1920	[c] 15,639	9,707	1923	[d] 16,671	13,115

[a] Prior to Sept. 22, 1922, imports recorded as ore; beginning with new tariff, recorded as molybdenum content of ore.
[b] Not separately classified prior to July, 1918.
[c] Recorded as molybdenum ore.
[d] Recorded as molybdenum content of ore.

For imports of ferromolybdenum see under Ferroalloys. Exports of ferromolybdenum are not separately classified.

NICKEL

PRODUCTION

Since 1920 no nickel has been produced in the United States from domestic materials except as a by-product of copper refining. Work has been done at various times on the property of the Missouri Cobalt Co. near Fredericktown, Mo., and nickel was produced from its complex sulphides in 1919 and 1920. Considerable quantities of nickel matte imported from Canada are, however, refined in the United States by the International Nickel Co., but only for making monel metal. Matte made from new Caledonian ores is refined at New Brunswick, N. J., by the U. S. Nickel Co. In 1922 for practically the first time in many years competition of nickel refined in a foreign country was seen in the United States when the Mond Nickel Co. of England established an agency here for the sale of its metal refined by the carbonyl process.

All nickel produced in 1923 was in the form of sulphate.

Nickel content of nickel salts and metallic nickel produced in the United States as a by-product in the electrolytic refining of copper, 1918–1923, and from mixed ores in 1919 and 1920

Year	Short tons	Value	Year	Short tons	Value
1918	441	$401,000	1921	111	$86,000
1919 [a]	511	434,485	1922	208	133,191
1920 [a]	365	293,250	1923	100	71,605

[a] Including nickel produced from copper-lead-cobalt-nickel ores mined in Missouri.

IMPORTS AND EXPORTS

Nickel imported for consumption in the United States, 1919–1923

Year	Nickel, nickel ore and matte, nickel oxide, and alloys of nickel with copper, etc.		Manufactures and nickel sheets and strips	Total value
	Pounds	Value		
1919	36, 562, 388	$8, 334, 135	$90, 451	$8, 424, 586
1920	48, 492, 076	10, 657, 193	200, 464	10, 857, 657
1921	4, 396, 119	1, 210, 317	107, 155	1, 317, 472
1922	14, 919, 362	3, 945, 168	110, 176	4, 055, 344
1923	40, 669, 203	6, 601, 995	92, 977	6, 694, 972

Nickel imported for consumption in the United States, 1922 and 1923, by classes

Class	1922		1923	
	Pounds	Value	Pounds	Value
Nickel ore and matte (nickel content)	3, 085, 632	$396, 726	14, 601, 820	$1, 145, 645
Nickel alloys, pig, bars, etc	11, 341, 360	3, 438, 225	23, 783, 041	5, 159, 888
Nickel oxide	492, 370	110, 217	2, 284, 342	296, 462
All other manufactures	(a)	110, 176	127, 324	92, 977
		4, 055, 344	40, 796, 527	6, 694, 972

[a] Quantity not recorded prior to new tariff. Imports from Sept. 22 to Dec. 31, 1922, were 24,586 pounds, valued at $23,710.

Nickel, nickel oxide, and matte[a] exported from the United States, 1918–1923

Year	Pounds	Value	Year	Pounds	Value
1918	17, 469, 500	$6, 927, 041	1921	425, 851	$103, 372
1919	3, 810, 656	1, 697, 544	1922	9, 317, 520	1, 016, 091
1920	1, 215, 232	574, 845	1923 [a]	11, 200	626

[a] Nickel oxide and matte only after 1922. Separate figures for nickel not available. See following table.

Beginning with 1922, additional classes of nickel exports are shown. The complete exports for 1922 and 1923 are given in the following table:

Nickel exported from the United States, 1922 and 1923, by classes

Class	1922		1923	
	Pounds	Value	Pounds	Value
Oxide and matte	9, 311, 680	$1, 013, 069	11, 200	$626
Nickel	5, 840	3, 022	868, 158	307, 269
Monel metal and other alloys	913, 983	196, 702		
Manufactures	249, 467	179, 094	488, 088	290, 452
Nickel or German silver in bars, rods, or sheets	402, 922	121, 755	481, 178	145, 518

OILSTONES AND SCYTHESTONES

[See Abrasive materials]

ORE

Crude metallic ores (including tailings, etc.) shipped from or treated at the mine in the United States, 1919–1923, in short tons

[Figures rounded]

Class of ore	1919	1920	1921	1922	1923
Aluminum ore (bauxite)	422,000	584,000	156,000	347,000	585,000
Chromite	6,000	3,000	300	400	250
Dry and siliceous (gold and silver) ore	9,302,000	8,590,000	8,436,000	8,728,000	9,122,000
Iron ore [a]	63,050,000	77,539,000	29,750,000	56,641,000	78,092,000
Manganese ore (35 per cent or more Mn.) [a]	62,000	106,000	15,000	15,000	35,000
Manganiferous ore (5 to 35 per cent Mn.) [a]	363,000	713,000	80,000	668,000	1,559,000
Quicksilver ore	188,000	109,000	35,000	43,000	51,000
Copper ore:					
Western States	27,841,000	30,236,000	9,221,000	21,383,000	39,433,000
Central States	7,690,000	5,939,000	3,611,000	4,952,000	5,363,000
Eastern States	591,000	590,000	564,000	558,000	777,000
	36,122,000	36,765,000	13,396,000	26,893,000	45,573,000
Copper-lead and copper-lead-zinc ore	18,000	27,000	14,000	52,000	162,000
Lead ore:					
Western States	1,815,000	2,368,000	2,054,000	2,124,000	2,288,000
Central States	4,304,000	4,822,000	5,075,000	5,162,000	5,320,000
Eastern States	8,000	10,000		2,000	5,500
	6,127,000	7,200,000	7,129,000	7,288,000	7,613,000
Lead-zinc ore:					
Western States	1,366,000	1,444,000	122,000	445,000	1,204,000
Central States	10,234,000	10,939,000	3,614,000	8,110,000	9,783,000
	11,600,000	12,383,000	3,736,000	8,555,000	10,987,000
Zinc ore:					
Western States	89,000	482,000	10,000	471,000	724,000
Central States	949,000	1,058,000	933,000	1,206,000	2,154,000
Eastern States	1,331,000	1,111,000	765,000	990,000	1,186,000
	2,369,000	2,651,000	1,708,000	2,667,000	4,064,000
Grand total	129,629,000	146,670,000	64,455,000	111,897,000	157,843,000

[a] Exclusive of fluxing ore.

PEAT

PRODUCTION

Peat produced in the United States, 1919–1923, by uses

Year	Fertilizer and fertilizer ingredient		Stock food		Fuel		Other products [a]		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1919	54,690	$557,240	6,402	$98,940	(b)	(b)	8,105	$49,352	69,197	$705,532
1920	63,272	773,635	[c] 9,182	[c] 143,047	750	$5,050	(c)	(c)	73,204	921,732
1921	29,460	251,046	[d] 946	[d] 9,073	(d)	(d)	(d)	(d)	30,406	260,119
1922	57,747	369,165	[c] 1,893	[c] 20,864	1,040	7,700	(c)	(c)	60,680	397,729
1923	57,907	351,641	[d] 3,448	[d] 25,193	(d)	(d)	(d)	(d)	61,355	376,834

[a] Peat moss, stable litter, and packing material. Also peat for fuel in 1919.
[b] Included under "Other products."
[c] Small quantity of miscellaneous products included under "Stock food."
[d] Small quantity of peat for fuel and miscellaneous products included under "Stock food."

IMPORTS

Peat moss imported for consumption in the United States, 1918–1923

Year	Short tons	Value	Year	Short tons	Value
1918			1921	3,450	$22,754
1919	464	$16,345	1922	4,805	33,034
1920	2,762	36,201	1923	5,973	43,184

No exports of peat are reported.

PETROLEUM

PRODUCTION

Petroleum produced in the United States, 1918–1923

[Barrels of 42 United States gallons]

Year	Barrels	Value at wells	Year	Barrels	Value at wells
1918	355,928,000	$703,944,000	1921	472,183,000	$814,745,000
1919	378,367,000	760,266,000	1922	557,531,000	895,111,000
1920	442,929,000	1,360,745,000	1923	732,407,000	978,430,000

Petroleum produced in the United States, 1921–1923, by fields

Field	1921		1922		1923	
	Barrels	Value at wells	Barrels	Value at wells	Barrels	Value at wells
Appalachian	30,451,000	$87,896,000	29,180,000	$80,448,000	28,225,000	$78,886,000
Lima-Indiana	2,404,000	5,423,000	2,269,000	5,063,000	2,404,000	4,820,000
Illinois and southwestern Indiana	10,934,000	22,486,000	10,231,000	21,018,000	9,500,000	17,690,000
Mid-Continent	258,461,000	426,720,000	310,992,000	532,738,000	348,460,000	535,060,000
Gulf coast	36,371,000	43,037,000	37,117,000	44,313,000	33,271,000	46,120,000
Rocky Mountain	20,950,000	26,033,000	29,261,000	38,117,000	47,653,000	53,082,000
California	112,600,000	203,138,000	138,468,000	173,381,000	262,876,000	242,731,000
Other fields [a]	12,000	12,000	13,000	33,000	18,000	41,000
	472,183,000	814,745,000	557,531,000	895,111,000	732,407,000	978,430,000

[a] Alaska, Missouri, and New Mexico.

Petroleum produced in the United States, 1921–1923, by States

State	1921		1922		1923	
	Barrels	Value at wells	Barrels	Value at wells	Barrels	Value at wells
Arkansas	10,473,000	$12,746,000	12,712,000	$20,416,000	36,610,000	$25,400,000
California	112,600,000	203,138,000	138,468,000	173,381,000	262,876,000	242,731,000
Colorado	108,000	132,000	97,000	114,000	86,000	102,000
Illinois	10,043,000	20,632,000	9,383,000	19,291,000	8,707,000	16,250,000
Indiana	1,158,000	2,414,000	1,087,000	2,225,000	1,043,000	1,900,000
Kansas	36,456,000	68,694,000	31,766,000	56,131,000	28,250,000	45,970,000
Kentucky	9,013,000	16,736,000	8,973,200	17,758,000	8,069,000	15,900,000
Louisiana	27,103,000	42,469,000	35,376,000	53,169,000	24,919,000	36,530,000
Montana	1,509,000	2,373,000	2,449,000	4,048,000	2,782,000	4,080,000
New York	988,000	3,262,000	1,000,000	3,144,000	1,250,000	4,140,000
Ohio	7,335,000	21,512,000	6,781,000	17,369,000	7,085,000	17,050,000
Oklahoma	114,634,000	183,185,000	149,571,000	258,160,000	160,929,000	279,700,000
Pennsylvania	7,418,000	24,746,000	7,425,000	23,834,000	7,609,000	25,320,000
Tennessee	12,000	21,000	9,800	17,000	8,000	14,000
Texas	106,166,000	162,663,000	118,684,000	189,175,000	131,023,000	193,580,000
West Virginia	7,822,000	26,482,000	7,021,000	22,891,000	6,358,000	20,822,000
Wyoming	19,333,000	23,528,000	26,715,000	33,955,000	44,785,000	48,900,000
Other[a]	12,000	12,000	13,000	33,000	18,000	41,000
	472,183,000	814,745,000	557,531,000	895,111,000	732,407,000	978,430,000

[a] Alaska, Missouri, and New Mexico

World's production of petroleum in 1923 and since 1857, by countries

Country	1923				1857–1923			
	Barrels of 42 United States gallons	Metric tons	Cubic meters	Percentage of total by volume	Barrels of 42 United States gallons	Metric tons	Cubic meters	Percentage of total by volume
United States	732,407,000	100,371,000	116,440,000	71.9	7,191,989,000	985,195,000	1,143,384,000	63.2
Mexico	149,585,000	22,704,000	23,781,000	14.7	1,061,784,000	159,040,000	168,802,000	9.3
Russia	39,156,000	5,435,000	6,225,000	3.8	2,007,837,000	266,320,000	319,206,000	17.6
Persia	28,326,000	3,774,000	4,503,000	2.8	118,245,000	15,763,000	18,799,000	1.0
Dutch East Indies	19,868,000	2,833,000	3,159,000	1.9	273,555,000	37,330,000	43,490,000	2.4
Rumania	10,867,000	1,512,000	1,728,000	1.1	194,539,000	27,302,000	30,928,000	1.7
India	8,320,000	1,168,000	1,323,000	.8	149,044,000	19,990,000	23,695,000	1.3
Peru	5,699,000	752,000	906,000	.6	44,509,000	5,910,000	7,077,000	.4
Poland	5,402,000	737,000	859,000	.5	184,976,000	25,571,000	29,408,000	1.6
Venezuela	4,201,000	639,000	668,000	.4	9,170,000	1,395,000	1,458,000	
British Borneo (Sarawak)	3,940,000	567,000	626,000	.4	12,342,000	1,776,000	1,962,000	
Argentina	3,400,000	497,000	540,000	.3	15,752,000	2,299,000	2,504,000	
Trinidad	3,051,000	424,000	485,000	.3	19,207,000	2,671,000	3,053,000	
Japan and Taiwan	1,805,000	251,000	287,000	.2	47,681,000	6,623,000	7,580,000	
Egypt	1,054,000	153,000	170,000		10,636,000	1,531,000	1,693,000	
Colombia	424,000	61,000	67,000		747,000	107,000	118,000	
France	403,000	57,000	64,000		2,341,000	330,000	372,000	
Germany	312,000	44,000	50,000		16,299,000	2,197,000	2,592,000	1.5
Canada	170,000	23,000	27,000		25,400,000	3,388,000	4,038,000	
Czechoslovakia	74,000	11,000	12,000		405,000	60,000	65,000	
Italy	34,000	5,000	5,000	.3	1,141,000	162,000	181,000	
Barbados	10,000				(a)	(a)	(a)	
Algeria	9,000				59,000	8,000	9,000	
Cuba	4,000	16,000	19,000					
England	1,000				688,000	94,000	111,000	
Other (estimate)	98,000							
	1,018,620,000	142,034,000	161,944,000	100.0	11,388,346,000	1,565,062,000	1,810,525,000	100.0

[a] Included under "Other."

STOCKS

Stocks of crude petroleum held on December 31, 1921–1923, in barrels

		1921	1922	1923
Domestic petroleum—pipe-line and tank-farm stocks:				
East of California—				
Appalachian—				
New York, Pennsylvania, West Virginia, eastern and central Ohio	gross	4,933,000	6,200,000	6,606,000
	net	4,670,000	5,941,000	6,331,000
Kentucky	gross	2,264,000	3,041,000	3,007,000
	net	2,168,000	2,927,000	2,879,000
Lima-Indiana	gross	1,386,000	939,000	1,211,000
	net	1,014,000	685,000	975,000
Illinois and southwestern Indiana	gross	8,066,000	10,641,000	11,528,000
	net	7,567,000	10,140,000	11,091,000
Mid-Continent—				
Oklahoma, Kansas, central and northern Texas	gross	102,012,000	147,456,000	183,052,000
	net	91,983,000	136,601,000	171,781,000
North Louisiana and Arkansas	gross	10,912,000	16,617,000	32,927,000
	net	10,418,000	15,972,000	31,123,000
Gulf coast	gross	17,973,000	26,373,000	24,355,000
	net	17,606,000	24,781,000	23,974,000
Rocky Mountain	gross	1,647,000	2,002,000	19,718,000
	net	1,635,000	1,991,000	19,704,000
Total pipe-line and tank-farm stocks east of California	gross	149,193,000	213,269,000	282,404,000
	net	137,061,000	199,038,000	267,858,000
California [a]		35,022,000	49,375,000	62,162,000
Foreign petroleum held in the United States by importers: [b]				
At Atlantic coast stations—				
Crude		5,712,000	6,028,000	324,000
Topped oil topped in Mexico		1,599,000	2,642,000	2,806,000
At Gulf coast stations—				
Crude		5,413,000	6,059,000	1,059,000
Topped oil topped in Mexico		816,000	1,436,000	565,000
Total foreign [b]		13,540,000	16,165,000	4,754,000
Total of net pipe-line and tank-farm stocks east of California; gross pipe-line, tank-farm, and producers' stocks in California; and stocks of foreign petroleum held in the United States by importers [b]		185,623,000	264,578,000	334,774,000
Producers' stocks (not including California)		5,139,000	8,428,000	9,850,000
		190,762,000	273,006,000	344,624,000

[a] Producers', pipe-line, and tank-farm stocks of crude oil, residuum, and tops.
[b] In 1921 and 1922 includes petroleum held by importers at refineries (1921, quantity unknown; 1922, 11,103,000 barrels) and elsewhere; in 1923 excludes petroleum held by importers at refineries.

CONSUMPTION

Indicated deliveries to consumers of domestic and foreign crude petroleum in the United States, 1921–1923, in barrels

	1921	1922	1923
Domestic petroleum (by field of origin):			
Appalachian	27,188,000	27,184,000	27,788,000
Lima-Indiana	2,439,000	2,589,000	2,126,000
Illinois and southwestern Indiana	6,346,000	7,649,000	8,563,000
Mid-Continent	230,494,000	257,838,000	297,051,000
Gulf coast	29,519,000	30,037,000	34,103,000
Rocky Mountain	19,890,000	28,487,000	29,640,000
California	99,818,000	124,115,000	250,089,000
Other	12,000	13,000	18,000
Deliveries to domestic consumers and exports [a]	415,706,000	477,912,000	649,378,000
Exports	8,866,000	9,995,000	17,061,000
Deliveries to consumers in the United States and Territories	406,840,000	467,917,000	632,317,000
Foreign petroleum: Deliveries to consumers in the United States and Territories [b]	119,192,000	124,515,000	81,999,000
Deliveries to consumers of domestic and foreign petroleum in the United States and Territories	526,032,000	592,432,000	714,316,000

[a] Production plus domestic stocks at beginning of year minus domestic stocks at end of year.
[b] Imports of "mineral crude oil" minus exports of foreign crude oil plus decrease or minus increase of stocks of foreign petroleum held in the United States by importers.

IMPORTS AND EXPORTS

Crude petroleum imported into and exported from the United States, 1919–1923

Year	Imports		Exports [a]	
	Barrels	Value	Barrels	Value
1919	52, 821, 567	$26, 442, 881	5, 924, 320	$14, 805, 546
1920	106, 175, 289	55, 799, 254	8, 044, 907	28, 990, 444
1921	125, 363, 983	66, 547, 379	8, 865, 497	20, 204, 491
1922	127, 308, 423	70, 383, 309	9, 995, 093	18, 348, 110
1923	82, 015, 025	53, 882, 259	17, 060, 771	23, 111, 832

[a] Exports of refined products and shipments of crude petroleum to Alaska, Hawaii, Porto Rico, and the Philippine Islands, and foreign petroleum reexported are not included. Exports of foreign crude petroleum have been as follows: 1919, 94, 331 barrels, valued at $42,520; 1920, 712,185 barrels, $996,430; 1921, 74,136 barrels, $57,407; 1922, 167,724 barrels, $74,121; 1923, 324,607 barrels, $150,358.

PHOSPHATE ROCK

PRODUCTION

Phosphate rock, produced in the United States, sold in 1918–1923

Year	Long tons	Value	Year	Long tons	Value
1918	2, 490, 760	$8, 214, 463	1921	2, 064, 025	$12, 270, 070
1919	2, 271, 983	11, 591, 268	1922	2, 417, 883	10, 482, 846
1920	4, 103, 982	25, 079, 572	1923	3, 006, 706	11, 576, 049

IMPORTS AND EXPORTS

Phosphate rock imported for consumption in the United States, 1918–1923

Year	Long tons	Value	Year	Long tons	Value
1918			1921	3, 535	$43, 960
1919	34	$457	1922	5, 890	95, 846
1920	63	2, 090	1923	6, 725	92, 263

Phosphate rock exported from the United States, 1918–1923

Year	Long tons	Value	Year	Long tons	Value
1918	143, 455	$912, 485	1921	733, 312	$7, 320, 137
1919	378, 731	3, 567, 982	1922	719, 294	5, 858, 167
1920	1, 069, 712	10, 570, 175	1923	827, 551	5, 772, 171

PLATINUM AND ALLIED METALS

PRODUCTION

Reports received from refiners of crude platinum, gold bullion, nickel, and copper indicate that 49,797 troy ounces of refined new metals of the platinum group were recovered in 1923, of which about 3,472 ounces are believed to be of domestic origin.

New platinum and allied metals recovered by refiners in the United States, 1919–1923, in troy ounces

Year	Platinum	Palladium	Iridium	Osmiridium	Other	Total
1919	40,220	3,807	401	402	279	45,109
1920	36,015	4,309	418	409	393	41,544
1921	51,791	2,686	286	581	1,026	56,370
1922	54,142	1,943	210	1,301	122	57,718
1923	46,780	1,934	280	787	16	49,797

Dealers and refiners reported recovery in 1923 of 47,872 ounces of secondary platinum metals derived from refining scrap and sweeps. The figures that make up this total probably represent some duplication, as the same metal may be handled as scrap several times in a year.

Secondary platinum and allied metals recovered in the United States, 1919–1923, in troy ounces

Year	Platinum	Palladium	Iridium	Other	Total
1919	54,545	3,467	3,504	----------	61,516
1920	51,255	3,100	3,355	----------	57,710
1921	39,131	4,887	1,776	229	46,023
1922	40,062	4,193	1,937	496	46,688
1923	39,152	6,246	2,021	453	47,872

IMPORTS AND EXPORTS

Platinum and allied metals imported for consumption in the United States, 1922 and 1923

Metal	1922		1923	
	Troy ounces	Value	Troy ounces	Value
Platinum or crude platinum and unmanufactured products, ingots, bars, sheets, wire	94,939	$7,790,898	86,417	$8,923,037
Platinum, manufactured products, vases, retorts, etc.[a]	45	[b] 11,464	103	4,769
Iridium	1,899	298,567	1,611	276,539
Osmiridium	2,165	242,637	1,174	150,074
Osmium	1,012	81,231	1,462	147,154
Palladium	9,754	537,684	14,578	857,071
Rhodium	111	16,227	805	86,569
Ruthenium	100	4,839	487	21,492
	110,025	8,983,547	106,637	10,466,705

[a] Classification in 1923 is "manufactures of, except jewelry."
[b] Includes articles to the value of $5,735 (quantity not given), imported under duty Jan. 1 to Sept. 21, 1922.

Platinum exported from the United States, 1919–1923

Year	Unmanufactured		Manufactures of, except jewelry	
	Troy ounces	Value	Troy ounces	Value
1919	522	$75,066	[a]	$54,529
1920	1,302	177,115	[a]	111,014
1921	3,272	244,473	741	85,216
1922 Crude, scrap, and old	143	13,149	486	35,967
1922 Ingots, sheets, wire, and alloys	1,313	127,047		
1923	1,151	128,599	592	65,073

[a] Quantity not given.

POTASH

PRODUCTION

Potash produced and sold in the United States, 1919–1923

Year	Produced			Sold		
	Number of plants	Crude potash (short tons)	Available content of potash (K_2O) (short tons)	Crude potash (short tons)	Available content of potash (K_2O) (short tons)	Value f. o. b. plant
1919	102	116,634	32,474	166,063	45,728	$11,271,269
1920	66	166,834	48,077	139,963	41,444	7,463,026
1921	20	25,485	10,171	10,337	4,408	447,859
1922	12	25,176	11,714	22,028	11,313	463,512
1923	12	39,029	20,215	35,164	19,281	784,671

Potash produced and sold in the United States, 1922 and 1923, by sources

Source	Produced				Sold		
	Number of plants	Crude potash (short tons)	Available content of potash (K_2O)		Crude potash (short tons)	Available content of potash (K_2O) (short tons)	Value f. o. b. plant
			Short tons	Percentage of total			
1922							
Mineral:							
Natural brines, Dust from cement mills, Dust from blast furnaces	8	18,291	9,319	79.6	19,968	10,556	$414,041
Organic:							
Molasses distillery waste	2	6,581	2,299	19.6	2	1	30
Steffens waste water from beet-sugar refineries	2	304	96	.8	2,058	756	49,441
	12	25,176	11,714	100.0	22,028	11,313	463,512
1923							
Mineral:							
Natural brines	3	32,254	17,982	89.0	31,079	17,984	693,764
Dust from cement mills, Dust from blast furnaces	7				4,036	1,285	90,028
Organic:							
Molasses distillery waste	1	6,700	2,211	10.9	44	11	654
Steffens waste water from beet-sugar refineries	1	75	22	.1	5	1	225
	12	39,029	20,215	100.0	35,164	19,281	784,671

Potash produced in the United States, 1922 and 1923, by States

State	Number of plants	Crude potash (short tons)	Available content of potash (K_2O)	
			Short tons	Percentage of total
1922				
California	4	17,551	9,363	79.9
Indiana	1	100	30	.3
Maryland	1	6,535	2,287	19.5
Pennsylvania	5	990	34	.3
Porto Rico	1			
	12	25,176	11,714	100.0
1923				
California	3	31,536	17,924	88.7
Indiana	1	75	22	.1
Maryland	1	6,700	2,211	10.9
Nevada	1	718	58	.3
Pennsylvania	6			
	12	39,029	20,215	100.0

STOCKS

Potash held by the producers in the United States, December 31, 1922 and 1923, in short tons

Source	1922		1923	
	Crude potash	Available content of potash (K_2O)	Crude potash	Available content of potash (K_2O)
Mineral:				
Natural brines	11,289	5,771	10,309	4,890
Dust from blast furnaces	6,508	1,585	5,515	1,215
Dust from cement mills				
Organic:				
Molasses distillery waste	12,203	4,267	18,900	6,237
Steffens waste water from beet-sugar refineries	100	30	70	21
	30,100	11,653	34,794	12,363

IMPORTS AND EXPORTS

Potash materials imported for consumption in the United States, 1919–1923

Year	Potash salts used mainly in the fertilizer industry [a]			Potash salts used mainly in chemical industries [b]			Total		
	Short tons		Value	Short tons		Value	Short tons		Value
	Gross weight	Potash (K_2O) content		Gross weight	Potash (K_2O) content		Gross weight	Potash (K_2O) content	
1919	127,416	28,484	$4,163,739	33,430	11,135	$6,028,077	160,846	39,619	$10,191,816
1920	918,698	197,795	33,885,627	63,564	26,997	9,504,156	982,262	224,792	43,389,783
1921	212,752	64,126	7,743,364	32,453	14,572	3,739,090	245,205	78,698	11,482,454
1922	632,711	186,264	10,951,197	34,198	15,151	4,415,891	666,909	201,415	15,367,088
1923	712,701	194,210	10,633,475	35,824	15,740	4,771,097	748,525	209,950	15,404,572

[a] Includes kainite, manure salts, muriate, and sulphate. Considerable quantities of muriate and some sulphate were used in chemical industries.

[b] Includes bicarbonate, bichromate, bitartrate, bromide, carbonate, caustic, chlorate, chromate, cyanide, ferricyanide, ferrocyanide, iodide, nitrate, perchlorate, permanganate, and Rochelle salt.

Domestic potash salts exported from the United States, 1922 and 1923

Material	1922			1923		
	Short tons		Value	Short tons		Value
	Gross weight	Potash (K_2O) content		Gross weight	Potash (K_2O) content	
Potassium bichromate	2,215	886	$433,552	1,631	652	$295,751
Potassium chlorate	281	107	51,066	100	38	21,995
All other potassium salts	3,742	1,646	296,378	2,266	997	188,091
	6,238	2,639	780,996	3,997	1,687	505,837

PUMICE

[See Abrasive materials]

PYRITES

PRODUCTION

Pyrites produced in the United States, 1918–1923

Year	Long tons	Value	Year	Long tons	Value
1918	464,494	$2,644,515	1921	157,118	$711,432
1919	420,647	2,558,172	1922	169,043	671,241
1920	310,777	1,596,961	1923	181,628	661,000

IMPORTS AND EXPORTS

Pyrites containing more than 25 per cent of sulphur imported for consumption in the United States, 1918–1923

Year	Long tons	Value	Year	Long tons	Value
1918	496,792	$2,741,676	1921	216,229	$818,852
1919	388,973	2,176,565	1922	279,445	1,199,076
1920	332,606	1,600,832	1923	263,695	1,254,389

Exports of "pyrites or other sulphur ore" in 1922 amounted to 323 long tons, valued at $4,325. Data for earlier years and for 1923 are not separately shown.

QUARTZ

[See under Silica]

QUICKSILVER

PRODUCTION

Quicksilver produced in the United States, 1918–1923

[Flasks of 75 pounds]

Year	Flasks	Value	Year	Flasks	Value
1918	32,883	$3,863,752	1921	6,339	$300,595
1919	21,415	1,933,560	1922	6,375	368,348
1920	13,392	1,066,807	1923	7,937	521,302

IMPORTS AND EXPORTS

Quicksilver imported for consumption in the United States, 1918–1923

Year	Flasks	Value	Year	Flasks	Value
1918	6,719	$533,622	1921	10,601	$457,993
1919	10,635	791,226	1922	16,920	757,842
1920	14,169	971,510	1923	18,073	816,043

Quicksilver exported from the United States, 1918–1923

Year	Flasks	Value	Year	Flasks	Value
1918	3,098	$338,620	1921	393	$18,869
1919	9,107	817,328	1922	291	15,910
1920	1,553	129,993	1923	318	25,195

PRICES

Average yearly prices of quicksilver per flask in the United States and the United Kingdom, 1918–1923

Year	San Francisco [a] (domestic)	New York [b]	London [c]	Year	San Francisco [a] (domestic)	New York [b]	London [c]
			£ s. d.				£ s. d.
1918	$117.50	$123.47	[d]	1921	$47.42	$45.46	11 3 5
1919	90.29	92.15	20 9 5½	1922	57.78	58.95	11 11 6
1920	79.66	81.12	20 14 9	1923	65.68	66.70	10 4 9

[a] 1918–1921: Min. and Sci. Press, San Francisco; 1922–23: Eng. and Min. Jour.-Press, New York.
[b] 1918–1921: Eng. and Min. Jour., New York; 1922–23: Eng. and Min. Jour.-Press, New York.
[c] Min. Jour. (London).
[d] Quoted as "nominal" only.

RADIUM

[See Uranium and vanadium ores]

SALT

PRODUCTION

Salt sold or used by the producers in the United States, 1919–1923

Year	Short tons				Total value
	Manufactured (evaporated)	In brine	Rock salt	Total	
1919	2,392,290	2,850,639	1,639,973	6,882,902	$27,074,694
1920	2,409,924	2,819,916	1,610,189	6,840,029	29,894,075
1921	1,931,243	1,577,335	1,472,576	4,981,154	24,557,966
1922	2,276,683	2,569,042	1,947,124	6,792,849	27,464,838
1923	2,239,872	2,787,239	2,103,602	7,130,713	27,795,941

Salt sold or used by the producers in the United States, 1922 and 1923, by States

State	1922		1923	
	Short tons	Value	Short tons	Value
California	257,790	$1,211,197	252,465	$1,327,917
Idaho	21	240	31	310
Kansas	759,459	3,849,427	845,163	3,570,135
Louisiana	336,852	1,657,708	359,161	1,808,762
Michigan	2,005,088	8,693,604	2,127,412	8,684,148
New Mexico	718	5,747	525	5,250
New York	1,960,867	7,066,409	2,065,842	7,431,155
Ohio	1,105,757	3,749,564	1,102,387	3,695,248
Porto Rico	[a]	[a]	5,875	8,225
Utah	81,909	387,093	81,449	468,765
West Virginia	25,188	283,257	31,589	284,196
Undistributed [b]	259,200	560,592	258,814	511,830
	6,792,849	27,464,838	7,130,713	27,795,941

[a] Included under "Undistributed."
[b] 1922: Porto Rico, Texas, and Virginia; 1923: Nevada, Texas, and Virginia.

IMPORTS AND EXPORTS

Salt imported for consumption in the United States, 1918–1923

Year	Short tons	Value	Year	Short tons	Value
1918	40,290	$281,468	1921	93,095	$531,031
1919	59,514	242,704	1922	113,922	522,338
1920	137,654	676,499	1923	88,750	383,258

Salt exported from the United States, 1918–1923

Year	Short tons	Value	Year	Short tons	Value
1918	136,783	$1,677,577	1921	109,563	$1,415,471
1919	119,416	1,396,625	1922	134,989	1,429,172
1920	139,272	1,901,593	1923	125,529	1,211,226

SAND AND GRAVEL

PRODUCTION

Sand and gravel sold or used by the producers in the United States, 1919–1923

Year	Glass sand		Molding sand		Building sand	
	Short tons	Value	Short tons	Value	Short tons	Value
1919	1,827,409	$3,593,371	3,774,612	$4,153,990	21,969,736	$12,296,664
1920	2,165,926	4,748,690	5,128,075	7,504,759	26,539,365	17,956,635
1921	1,280,359	2,314,314	1,906,977	2,451,966	24,565,605	16,053,413
1922	1,768,549	2,866,366	3,839,116	4,478,405	29,375,466	17,574,579
1923	2,034,958	3,751,778	5,559,644	6,730,417	39,234,762	23,751,244

Year	Other sand		Gravel		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1919	8,397,979	$6,345,654	34,606,671	$19,561,877	70,576,407	$45,951,556
1920	9,942,776	8,988,530	38,265,246	26,462,991	82,041,388	65,661,605
1921	10,542,013	8,230,257	41,550,054	27,434,295	79,845,008	56,484,245
1922	14,711,792	10,550,570	45,172,123	29,147,744	94,867,046	64,617,664
1923	20,535,907	14,240,126	72,566,882	42,430,089	139,932,153	90,903,654

IMPORTS AND EXPORTS

Sand and gravel imported for consumption in the United States, 1918–1923

Year	Short tons	Value	Year	Short tons	Value
1918	(a)	$91,465	1921	906,905	$771,734
1919	597,481	126,586	1922	[b] 451,943	[b] 238,386
1920	1,226,684	912,282	1923	[c] 477,762	[c] 259,820

[a] Quantities not recorded prior to July, 1918. During last six months of 1918 the imports were 284,036 tons, valued at $46,910.
[b] Includes 65,848 tons of gravel, valued at $27,434, and 1,290 tons of glass sand, valued at $1,112, imported after new tariff went into effect, Sept. 22. Not separately shown prior to that time.
[c] Includes 198,960 tons of gravel, valued at $99,687, and 2,309 tons of glass sand, valued at $3,008.

Sand and gravel exported from the United States, 1918–1923

Year	Short tons	Value	Year	Short tons	Value
1918	(a)	$619,414	1921	(a)	$379,982
1919	(a)	382,070	1922	356,520	400,199
1920	(a)	669,945	1923	551,233	598,633

[a] Quantities not recorded prior to 1922.

SAND-LIME BRICK

Sand-lime brick, produced in the United States, sold in 1918–1923 [a]

Year	Number of operators	Thousands	Value	Year	Number of operators	Thousands	Value
1918	42	98,399	$883,929	1921 [b]	26	97,126	$1,268,502
1919	35	146,947	1,705,163	1923 [b]	33	213,425	2,471,536
1920	37	169,761	2,490,283				

[a] Canvass discontinued by Geological Survey after 1920. No canvass for 1922.
[b] According to Bureau of the Census.

Imports and exports of sand-lime brick are not reported separately.

SELENIUM

PRODUCTION

Only two companies reported the production of selenium in 1923; reports were received from three firms for 1922. The output was largely consumed by the ceramic and glass industries. Most of the selenium produced is a by-product in the electrolytic refining of copper.

Selenium, produced in the United States, sold in 1918–1923

Year	Pounds	Value	Year	Pounds	Value
1918	103,694	$206,540	1921	55,978	$89,148
1919	60,025	125,966	1922	123,565	177,542
1920	92,141	175,508	1923 (estimate)	64,000	134,400

IMPORTS

Selenium and selenium salts imported for comsumption in the United States, 1918–1923

1918		1921	$2,099
1919	$25,866	1922	2,530
1920		1923	1,653

SILICA

PRODUCTION

Quartz sold by the producers in the United States, 1919–1923

Year	Crude		Ground		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1919	51,774	$135,187	11,558	$238,384	63,332	$373,571
1920	59,423	142,397	8,767	177,953	68,190	320,350
1921	8,570	39,660	2,682	45,297	11,252	84,957
1922	5,085	23,093	5,568	78,254	10,653	101,347
1923	14,159	66,723	6,442	126,907	20,601	193,630

Silica sold by the producers in the United States for pottery, paints, fillers, polishers, abrasives, and other uses, 1922 and 1923

Material	1922		1923	
	Short tons	Value	Short tons	Value
Quartz (vein quartz, pegmatite, and quartzite)	10,653	$101,347	20,601	$193,630
Sand and sandstone [a]	163,295	1,061,057	249,467	1,672,961
Tripoli (including rottenstone) (ground and otherwise prepared)	30,205	316,728	27,082	382,757
Diatomaceous earth	44,761	386,669	65,833	699,406
	248,914	1,865,801	362,983	2,948,754

[a] Includes only finely ground material. Figures probably incomplete.

IMPORTS

Imports of crude silica in 1923 amounted to 34 short tons, valued at $550. Similar imports were not recorded prior to September 22, 1922, but from that date to the end of the year 1 ton, valued at $45, was imported. The Bureau of Foreign and Domestic Commerce records imports of "flint, flints, and flint stones, unground," from several countries. These imports are partly flint pebbles for use in grinding mills and partly material for uses such as are listed above. The figures can not be accurately separated.

"Flint, flints, and flint stones, unground" imported for consumption in the United States, 1918–1923

Year	Short tons	Value	Year	Short tons	Value
1918	[a]	$127,808	1921	10,084	$116,157
1919	19,798	250,096	1922	16,040	145,805
1920	26,636	338,630	1923	15,952	130,974

[a] Quantities not recorded prior to July, 1918. During last six months of 1918 the imports were 5,224 tons, valued at $55,440.

No exports of silica are reported.

SILICA BRICK

Silica brick, produced in the United States, sold in 1918–1923 [a]

Year	Thousands	Value	Year	Thousands	Value
1918	336, 562	$19, 987, 803	1921 [b]	104, 990	$5, 220, 640
1919	211, 420	10, 914, 898	1922 [b]	186, 547	7, 533, 409
1920	250, 582	15, 076, 821	1923 [b]	258, 388	12, 855, 067

[a] Canvass discontinued by the Geological Survey after 1920.
[b] According to Bureau of the Census.

Imports and exports of silica brick are not reported separately.

SILVER

[See under Gold and silver]

SLATE

PRODUCTION

Slate sold in the United States, 1919–1923, by uses

Year	Roofing slate		Mill stock		Slate for other uses [a]	Total value
	Number of squares (100 sq. ft.)	Value	Square feet	Value		
1919	454, 337	$3, 085, 957	7, 466, 000	$1, 782, 793	$1, 161, 898	$6, 030, 648
1920	396, 230	3, 524, 658	9, 910, 000	3, 147, 281	2, 054, 503	8, 726, 442
1921	348, 085	3, 197, 745	8, 970, 000	2, 719, 723	1, 404, 538	7, 322, 006
1922	479, 243	4, 069, 761	9, 276, 800	2, 899, 195	2, 207, 828	9, 176, 784
1923	507, 587	4, 582, 535	11, 109, 480	4, 159, 644	3, 334, 445	12, 076, 624

[a] Chiefly slate granules.

Value of slate sold in the United States, 1921–1923, by States

State	1921	1922	1923
Maine	$409, 303	$464, 713	$754, 826
New York	516, 956	642, 972	927, 398
Pennsylvania	3, 595, 386	4, 324. 294	5, 587, 670
Vermont	2, 346, 978	2, 907, 858	3, 857, 287
Virginia	212, 943	[a] 312, 652	[a] 321, 010
Undistributed [b]	240, 440	[c] 524, 295	[c] 628, 433
	7, 322, 006	9, 176, 784	12, 076, 624

[a] Exclusive of value of granules, which is included under "Undistributed."
[b] 1921 and 1922: Georgia, Maryland, New Jersey, and Tennessee, 1923: California, Georgia, Maryland, New Jersey, and Tennessee.
[c] Includes also value of granules for Virginia.

Slate sold in the United States, 1922 and 1923, by uses

Use		1922		1923	
		Quantity	Value	Quantity	Value
Roofing	squares	479,243	$4,069,761	507,587	$4,582,535
Approximate equivalent in short tons		161,700		171,300	
Electrical	square feet	1,363,300	996,322	2,182,890	1,754,717
Approximate equivalent in short tons		9,700		15,600	
Structural and sanitary	square feet	2,131,800	750,653	2,479,620	894,757
Approximate equivalent in short tons		15,300		17,730	
Grave vaults and covers	square feet	400,100	87,763	451,160	111,223
Approximate equivalent in short tons		5,700		6,450	
Blackboards and bulletin boards	square feet	3,518,700	880,985	4,415,710	1,186,864
Approximate equivalent in short tons		25,100		31,600	
Billiard table tops	square feet	383,900	141,445	527,680	180,981
Approximate equivalent in short tons		2,700		3,770	
School slates	pieces	2,766,600	42,027	2,144,900	31,102
Approximate equivalent in square feet		1,479,000		1,052,420	
Approximate equivalent in short tons		2,000		1,550	
Granules	short tons	379,980	2,177,061	462,260	3,268,554
Other	short tons (estimated)	5,500	30,767	16,540	65,891
Total (quantities approximate, in short tons)		607,680	9,176,784	726,800	12,076,624

IMPORTS AND EXPORTS

Value of slate imported for consumption in the United States, 1918–1923

1918	$321	1921	$2,923
1919	691	1922	2,753
1920	4,512	1923	16,881

Value of roofing slate exported from the United States, 1918–1923

1918	$65,224	1921	$101,630
1919	55,164	1922	97,811
1920	122,105	1923	78,780

The following figures for exports of slate other than roofing were collected by the United States Geological Survey from shippers of the products named:

Slate other than roofing exported from the United States, 1921–1923, by uses

Use		1921		1922		1923	
		Quantity	Value	Quantity	Value	Quantity	Value
School slates	cases [a]	17,463	$201,383	19,807	$194,962	21,502	$180,411
Electrical slate	square feet	55,459	53,505	47,219	41,427	[b] 209,594	[b] 105,332
Blackboards	do	155,551	52,598	104,293	32,217	91,267	30,442
Billiard tables	do	68,167	35,686	69,160	29,897	50,429	22,922
Structural	do	2,613	1,310	2,319	1,407	([b])	([b])
			344,482		299,910		339,107

[a] Cases weigh from 130 to 165 pounds each; average is 135 pounds.
[b] Small quantity of structural slate included with electrical.

Producers also report exporting 5,109 short tons of roofing granules, valued at $38,126, in 1923. Figures for earlier years are not available.

SOAPSTONE

[See Talc and soapstone]

SODIUM COMPOUNDS

PRODUCTION

Domestic sodium compounds sold in the United States, 1918–1921[a]

Year	Short tons	Value	Year	Short tons	Value
1918	9,997,310	$134,594,154	1920	9,774,289	$138,607,384
1919	9,166,581	118,836,347	1921	(b)	(b)

[a] The approximate constancy in these figures from year to year is due in large part to the inclusion of sodium chloride, the fundamental sodium compound from which most of the others are made.
[b] Canvass for sodium compounds (except for those derived from natural sources shown in following table) discontinued by Geological Survey after 1920.

Sodium salts, derived from natural sources in the United States, shipped by the producers, 1922 and 1923, by varieties

Salt	1922		1923	
	Short tons	Value	Short tons	Value
Sodium chloride (common salt):				
Salt in brine	2,569,042	$1,502,435	2,787,239	$1,566,341
Rock salt	1,947,124	7,489,644	2,103,602	7,843,419
Evaporated salt	2,276,683	18,472,759	2,239,872	18,386,181
Sodium salts (carbonate, bicarbonate, sulphate, trona, and borax)	45,406	1,415,774	59,440	1,775,940
	6,838,255	28,880,612	7,190,153	29,571,881

Borates (colemanite and naturally occurring borax) shipped by the producers in the United States, 1918–1923

Year	Short tons	Value	Year	Short tons	Value
1918	88,794	$2,263,230	1921	50,000	$1,600,000
1919	66,146	1,380,000	1922	85,220	2,705,140
1920	120,320	2,173,000	1923	136,650	3,994,790

IMPORTS AND EXPORTS

Sodium salts imported for consumption in the United States, 1922 and 1923, by varieties

Salt	1922		1923	
	Pounds	Value	Pounds	Value
Sodium acetate	[a] 341,541	[a] $16,744	619,942	$31,621
Sodium arsenate	15,166	1,366	16,515	1,879
Sodium benzoate	247	123		
Sodium bicarbonate [b]	77,458	1,335	38,455	1,185
Sodium bromide	[a] 61,736	[a] 85,414	114,341	10,574
Sodium carbonate:				
Soda ash	3,823,933	56,765	2,305,548	32,667
Monohydrate and sesquicarbonate	15,708	594	12,500	1,752
Sal soda				
Sodium chlorate	1,367,812	58,348	1,333,418	49,352
Sodium chloride (common salt)	227,844,000	522,338	177,499,641	383,258
Sodium chromate and sodium bichromate	22,731	1,540	245	73
Sodium cyanide	15,705,924	1,306,071	30,138,869	2,472,735
Sodium ferrocyanide (yellow prussiate of sodium)	4,139,012	639,647	1,045,808	170,344
Sodium formate	[a] 280	[a] 56	248	50
Sodium hydrosulphite and compounds	[a] 117,694	[a] 26,543	742,187	116,832
Sodium hydroxide or caustic soda	219,101	14,768	123,801	11,966
Sodium nitrate or Chilean nitrate	1,215,119,360	26,152,723	1,997,360,960	41,955,770
Sodium nitrite	1,461,528	58,302	4,685,527	209,029
Sodium phosphate	1,427,759	46,762	1,661,562	46,055
Sodium potassium tartrate (Rochelle salt)	502,435	74,290	328,489	40,917
Sodium silicate	761,479	18,517	602,668	12,182
Sodium sulphate, crude, or salt cake, and niter cake	1,583,677	13,461	11,124,152	93,911
Sodium sulphate crystals, or Glauber's salt	13,637,120	74,155	18,025,280	100,145
Sodium sulphide	9,166,090	285,176	15,696,591	422,797
Sodium sulphite	2,627,065	102,679	1,699,807	43,044
Sodium tetraborate, or refined borax	778	257	943	151
Sodium thiosulphate, or sodium hyposulphite	1,167,057	28,413	217,783	4,348
	1,501,206,691	29,586,387	2,265,395,280	46,212,637

[a] Not separately classified prior to Sept. 22, 1922, when new tariff went into effect.
[b] Or supercarbonate, or saleratus, and other salts containing 50 per cent or more of sodium bicarbonate.

Domestic sodium salts exported from the United States, 1918–1923

1918	$22,291,735	1921	$7,921,315
1919	18,545,420	1922	11,759,025
1920	27,191,439	1923	11,140,512

Domestic sodium salts exported from the United States, 1922 and 1923, by varieties

Salt	1922		1923	
	Short tons	Value	Short tons	Value
Sodium bicarbonate	7,928	$341,459	8,467	$387,861
Sodium carbonate:				
Soda ash	14,814	678,983	14,512	729,870
Sal soda	5,732	186,284	6,112	179,006
Sodium chloride (common salt)	134,989	1,429,172	125,529	1,211,226
Sodium cyanide	624	235,224	2,503	473,675
Sodium hydroxide	73,370	5,271,528	57,342	3,827,403
Sodium silicate	14,565	302,161	16,552	316,543
Sodium tetraborate (borax)	8,825	875,101	20,276	1,607,419
All other sodium salts	48,759	2,439,113	74,382	2,407,509
	309,606	11,759,025	325,675	11,140,512

Foreign sodium salts reexported from the United States, 1919–1923

Year	Sodium chloride (common salt)		Sodium cyanide		Sodium nitrate		All other sodium salts
	Short tons	Value	Short tons	Value	Short tons	Value	
1919	457	$7,992			15,314	$1,299,563	$388,943
1920	417	6,252	78	$12,123	22,197	1,448,226	98,386
1921	651	5,969	703	117,258	37,033	2,011,109	27,224
1922	619	6,836	82	11,593	14,601	693,166	74,113
1923			325	42,913	13,076	623,534	51,710

STEEL

[See Iron ore, pig iron, and steel]

STONE

PRODUCTION

Stone sold or used by the producers in the United States, 1919–1923, by varieties

Year	Granite		Basalt and related rocks (trap rock)		Sandstone		Marble	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1919	4, 221, 220	$19, 345, 714	7, 410, 770	$8, 944, 686	2, 623, 270	$5, 283, 842	333, 400	$8, 042, 297
1920	4, 760, 000	24, 954, 908	9, 219, 200	12, 260, 148	3, 343, 000	7, 310, 290	431, 500	11, 069, 585
1921	4, 752. 180	20, 592, 217	8, 524, 480	11, 450, 899	2, 640, 460	6, 425, 339	315, 400	8, 580, 416
1922	5, 913, 120	21, 125, 869	10, 032, 900	12, 600, 611	3, 388, 130	7, 521, 044	427, 870	10, 534, 671
1923	7, 308, 930	30, 181, 796	10, 674, 470	13. 539, 648	4, 349, 270	9, 174, 706	562, 560	12, 863, 974

Year	Limestone		Other stone [a]		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1919	49, 759, 800	$53, 171, 701	1, 190, 540	$1, 920, 903	65, 539, 000	$96, 709, 143
1920	59, 290, 000	75, 655, 260	1, 483, 300	2, 291, 769	78, 527, 000	133, 541, 960
1921	45, 621, 000	57, 749, 594	1, 685, 220	2, 163, 801	63, 538, 740	106, 962. 266
1922	58. 928, 660	68, 397, 927	1, 520, 880	1, 886, 806	80, 211, 560	122, 066, 928
1923	76, 701, 360	89, 620, 007	3, 730, 870	4, 567. 110	103, 327, 460	159, 947, 241

[a] Includes mica schist, conglomerate, argillite, various light-colored volcanic rocks, serpentine not used as marble, and such other stone as can not be properly classed in any of the main groups.

Stone sold or used by the producers in the United States, 1922 and 1923, by uses

Use	1922		1923	
	Quantity	Value	Quantity	Value
Building stone—cubic feet	24, 262, 250	$25, 749, 398	26, 515, 520	$32, 416, 717
Approximate equivalent in short tons	1, 929, 260		2, 067, 030	
Monumental stone—cubic feet	2, 974, 920	10, 567, 110	5, 108, 650	16, 213, 230
Approximate equivalent in short tons	248, 270		424, 310	
Paving blocks—number	31, 208, 800	2, 685, 234	45, 866, 480	4, 003, 490
Approximate equivalent in short tons	326, 290		462, 210	
Curbing—cubic feet	2, 867, 800	2, 137, 193	3, 227, 810	2, 936, 313
Approximate equivalent in short tons	236, 030		252, 300	
Flagging—cubic feet	650, 590	406, 731	607, 600	422, 059
Approximate equivalent in short tons	53, 580		43, 860	
Rubble—short tons	632, 100	947, 680	882, 010	1, 298, 050
Riprap—do	2, 048, 580	1, 768, 939	3, 185, 900	2, 989, 068
Crushed stone—do	49, 763, 740	54, 130, 177	62, 322, 710	67, 928, 651
Furnace flux (limestone and marble)—long tons	16, 712, 500	14, 247, 024	22, 859, 330	20, 377, 138
Equivalent in short tons	18, 718, 000		25, 602, 450	
Refractory stone (ganister, mica schist, and dolomite)—short tons	902, 170	1, 136, 236	1, 151, 900	1, 572, 794
Manufacturing industries (limestone and marble)—short tons	3, 586, 250	3, 414, 073	4, 668, 470	4, 224, 230
Other uses (chiefly agricultural limestone)—do	1, 767, 290	4, 877, 133	2, 264, 310	5, 565, 501
Total (quantities approximate, in short tons)	80, 211, 560	122, 066, 928	103, 327, 460	159, 947, 241

IMPORTS AND EXPORTS

Stone imported for consumption in the United States, 1921–1923

Kind	1921		1922		1923	
	Quantity	Value	Quantity	Value	Quantity	Value
Marble:						
In blocks, rough, etc.....cubic feet	388,731	$810,850	[a] 546,400	[a] $1,137,154	[a] 699,412	[a] $1,513,192
Sawed.....do	[b]	105	42	112	134	310
Slabs or paving tiles...square feet	112,470	44,333	[a] 294,549	[a] 84,471	[a] 129,244	[a] 54,688
All other manufactures		103,273		[a] 196,754		[a] 283,169
Mosaic cubes of marble or onyx:						
Loose		30,865		25,259		21,617
Attached to paper		581		665		
		990,007		[a] 1,444,415		[a] 1,872,956
Onyx:						
In blocks, rough, etc.....cubic feet	1,010	4,115	[a] 2,134	[a] 12,357	(a)	(a)
Slabs or paving tiles...square feet	10,470	3,832	[a] 2,019	[a] 616	(a)	(a)
All other manufactures		9,990		[a] 4,906		(a)
		17,937		[a] 17,879		(a)
Granite:						
Dressed		108,219		183,776		270,412
Rough.....cubic feet	32,525	27,258	72,061	106,121	176,096	221,756
		135,477		289,897		492,228
Stone (other):						
Dressed		30,419		18,124		17,305
Rough (monumental or building stone).....cubic feet	53,116	54,181	63,944	68,416	80,770	74,377
Rough (other)		25,938		57,181		182,083
		110,538		143,721		273,765
Grand total		1,253,959		1,895,912		2,638,949

[a] Onyx not separately classified after new tariff went into effect (Sept. 22, 1922), but included under "Marble."
[b] Quantity not given.

Value of stone exported from the United States, 1919–1923

Kind	1919	1920	1921	1922	1923
Marble and stone, unmanufactured	$770,392	$774,442	$576,905	$681,658	$625,442
All other, manufactured	1,508,997	2,158,764	1,697,570	903,102	783,195
	2,279,389	2,933,206	2,274,475	1,584,760	1,408,637

STRONTIUM

PRODUCTION

Domestic strontium ore sold in the United States, 1916–1918[a]

Year	Short tons	Value
1916	250	$3,650
1917	4,035	87,700
1918	400	20,000

[a] The Geological Survey has no record of the production of domestic strontium ore prior to 1916, and no production has been reported since 1918.

Strontium chemicals, manufactured in the United States from domestic and imported crude ore, sold in 1918–1923

Year	Pounds	Value	Year	Pounds	Value
1918	4, 148, 270	$622, 546	1921	847, 368	$118, 655
1919	2, 191, 409	402, 057	1922	2, 040, 550	204, 022
1920	4, 713. 015	864, 251	1923	2, 676, 260	303, 719

IMPORTS

No record of the importation of strontium ore was kept at customs offices prior to September 22, 1922, but it is estimated that between 1,500 and 2,000 short tons of ore is imported annually. From September 22 to December 31, 1922, the imports were 1,000 pounds, valued at $40, and in 1923 they were 1,679 short tons, valued at $12,564.

Strontium chemicals and ore imported for consumption in the United States, 1918–1923

Year	Pounds	Value	Year	Pounds	Value
1918	[a]	$2, 459	1921	1, 212, 758	$4, 393
1919	1, 225, 952	3, 380	1922	390, 644	22, 986
1920	1, 659, 083	15, 479	1923	5, 281, 818	131, 420

[a] Quantities not recorded prior to July, 1918. During last six months of 1918, the imports were 185,920 pounds, valued at $356.

No exports of strontium ore or strontium chemicals have been reported.

SULPHUR

PRODUCTION

Sulphur produced and shipped in the United States, 1918–1923

Year	Produced (long tons)	Shipped		Year	Produced (long tons)	Shipped	
		Long tons	Approximate value			Long tons	Approximate value
1918	1, 353, 525	1, 266, 709	$27, 868, 000	1921	1, 879, 150	954, 344	$17, 000, 000
1919	1, 190, 575	678, 257	10, 252, 000	1922	1, 830, 942	1, 343, 624	22, 000, 000
1920	1, 255, 249	1, 517, 625	30, 000, 000	1923	2, 036, 097	1, 618, 841	26, 000, 000

IMPORTS AND EXPORTS

Sulphur imported for consumption in the United States, 1919–1923

Year	Crude		Refined		All other [a]		Total	
	Long tons	Value	Long tons	Value	Long tons	Value	Long tons	Value
1919	77	$1, 997	[b]	$15	24	$6, 621	101	$8, 633
1920	44	1, 722	50	2, 530	42	22, 576	136	26, 828
1921	4	226	35	2, 311	11	3, 341	50	5, 878
1922 (Jan. 1 to Sept. 21)	130	4, 259	1	50	128	8, 240	259	12, 549
1922 (Sept. 22 to Dec. 31)	[c]	[c]	[c]	[c]	[c]	[c]	37	2, 194
1923	[c]	[c]	[c]	[c]	[c]	[c]	465	21, 535

[a] Includes sulphur lac, flowers of sulphur, and other grades not otherwise provided for, but not pyrite.
[b] Less than 1 ton.
[c] Classes not separately shown after Sept. 22, 1922.

Sulphur exported from the United States, 1918–1923

Year	Long tons	Value	Year	Long tons	Value
1918	131,092	$3,626,638	1921	285,762	$4,524,768
1919	224,712	6,325,552	1922	487,969	7,209,357
1920	477,450	8,994,350	1923	474,475	7,216,107

TALC AND SOAPSTONE

PRODUCTION

Domestic talc and soapstone sold in the United States, 1919–1923, by classes

Year	Crude		Sawed and manufactured				Ground		Total	
			Talc		Soapstone					
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1919	15,625	$73,437	921	$147,339	16,504	$530,163	151,793	$1,601,736	184,843	$2,352,675
1920	11,008	43,820	1,415	139,335	19,707	709,400	178,505	2,142,894	210,635	3,035,449
1921	2,150	12,911	(a)	(a)	a17,423	a627,826	102,413	1,115,205	121,986	1,755,942
1922	4,981	22,582	654	86,333	22,700	712,144	170,349	2,038,838	198,684	2,859,897
1923	5,706	50,125	682	114,772	22,857	932,098	167,447	1,915,258	196,692	3,012,253

a Talc included under "Soapstone."

IMPORTS AND EXPORTS

Talc imported for consumption in the United States, 1919–1923

Year	Crude and unground steatite and French chalk		Talc, steatite, and French chalk—cut, ground, or washed a		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1919	1,641	$10,105	12,961	$248,899	14,602	$259,004
1920	941	7,206	21,739	443,514	22,680	450,720
1921	153	2,279	11,468	239,469	11,621	241,748
1922	248	9,850	18,196	367,528	18,444	377,378
1923	560	20,653	19,405	402,238	19,965	422,891

a Classification after Sept. 21, 1922, under new tariff is "Manufactures (except toilet preparations) wholly or partly finished."

No material that might be classed as soapstone is imported.

Exports of "talcum and other toilet powders" in 1923 amounted to 1,907 short tons, valued at $1,671,588, compared with 1,821 tons, valued at $1,397,542, in 1922. Exports were not separately classified prior to 1922.

TANTALUM

PRODUCTION

So far as is known to the Geological Survey, the only tantalum ore mined in the United States is the columbite shipped from time to time from pegmatites near Keystone and Hill City, S. Dak., by A. T. Roos:

Columbite, mined in the United States, shipped in 1918–1923

Year	Pounds	Value
1918	4,500	$2,250
1919	300	90
1920	4,000	1,450
1921	3,400	1,150
1922	600	240
1923	1,350	540

IMPORTS

Imports of "tantalum steel-hardening ores" in 1923 were 5,600 pounds, valued at $3,031. No tantalum or "tantalum steel-hardening ores" were imported in 1922 or 1920. In 1921, 6,785 pounds of "tantalum steel-hardening ores," valued at $1,327, and, under the heading "Tantalum," 1,229 pounds of material, valued at $788, were imported. From the value given for the "tantalum," it seems probable that this mineral was tantalum ore.

No separate record of exports is kept.

TELLURIUM

Nearly all the supply of metallic tellurium (less than 1,000 pounds) was sold in 1923 at an average of $2 a pound to manufacturers of electrical equipment, electroplating works, and chemical laboratories. Two producers, the Raritan Copper Works and the U. S. S. Lead Refinery, Inc., reported a production, but the Survey is not at liberty to publish the figures.

Imports and exports of tellurium are not reported.

THORIUM MINERALS

No monazite is known to have been produced in the United States since 1918.

Monazite sand and thorium nitrate imported for consumption in the United States, 1919–1923

Year	Monazite sand		Thorium nitrate	
	Pounds	Value	Pounds	Value
1919	632,568	$48,768	3,307	$5,250
1920	1,814,183	141,528	35,640	43,221
1921	50	40	44,554	89,672
1922	3,466,844	210,187	43,254	42,096
1923	253,730	11,334	24,027	29,789

Exports of thorium nitrate in 1922 amounted to 1,103 pounds, valued at $3,149. Data for earlier years and for 1923 are not separately shown.

TIN

PRODUCTION

Tin mined in the United States (including Alaska), 1918–1923

[Metallic tin obtainable from concentrates produced in tin mining]

Year	Short tons	Value	Year	Short tons	Value
1918	69	$118,500	1921	4	$2,400
1919	56	73,400	1922	[a] 1	912
1920	22	22,000	1923	[b] 2	1,623

[a] 2,800 pounds. [b] 3,782 pounds.

Smelter production of metallic tin in the United States, 1918–1923, in short tons

1918	10,284	1921	11,542
1919	12,236	1922	9,108
1920	17,652	1923	7,466

World's production of tin, 1922 and 1923, in metric tons

[Estimated recoverable metallic tin contained in ore mined]

Country	1922	1923
Bolivia	33,205	31,070
British Empire:		
Australia	2,600	3,677
England (Cornwall)	377	1,100
Federated Malay States	35,852	38,247
Nigeria	5,776	6,900
Nonfederated Malay States	1,800	1,870
Union of South Africa	360	825
India and other countries	2,000	1,600
China	10,695	8,882
Dutch East Indies:		
Banka	17,053	17,563
Billiton and Singkep	12,669	12,015
Siam	7,200	6,300
Other countries	2,000	2,070
	131,587	132,119

IMPORTS AND EXPORTS

Metallic tin imported for consumption in the United States, 1918–1923

Year	Short tons	Value	Year	Short tons	Value
1918	71,254	$93,144,218	1921	27,101	$16,645,719
1919	44,849	50,890,019	1922	67,416	40,797,986
1920	62,795	73,440,872	1923	77,206	61,092,354

Tin ore (concentrate) imported into the United States, 1918–1923

[General imports]

Year	Short tons	Value	Year	Short tons	Value
1918	18,394	$11,444,401	1921	15,340	$5,672,861
1919	19,196	11,871,948	1922	13,804	5,504,434
1920	34,148	18,795,162	1923	3,015	2,109,055

Exports of tin ore are insignificant.

Metallic tin (pigs, bars, etc.) of domestic manufacture exported from the United States, 1918–1923

Year	Short tons	Value	Year	Short tons	Value
1918	20	$31,952	1921	1,154	$748,077
1919	306	415,921	1922	901	574,792
1920	706	770,375	1923	840	646,250

PRICES

Average monthly prices, in cents per pound, of Straits tin in New York, 1922 and 1923 [a]

Month	1922	1923	Month	1922	1923
January	32.11	39.17	July	31.82	38.48
February	30.82	42.03	August	32.44	39.39
March	29.17	48.65	September	32.41	41.63
April	30.65	45.87	October	34.64	41.86
May	30.97	43.16	November	36.72	44.11
June	31.54	41.00	December	37.68	47.14

[a] Metal Statistics, 1924, p. 331.

Average yearly prices, in cents per pound, of Straits tin in New York, 1918–1923 [a]

1918	86.80	1921	30.00
1919	65.54	1922	32.58
1920	50.36	1923	42.71

[a] Metal Statistics, 1924, p. 331.

TITANIUM MINERALS

PRODUCTION

In 1923 the American Rutile Co. produced from its quarry at Roseland, Nelson County, Va., 270 short tons of rutile carrying about 95 per cent of TiO_2 and 466 tons of ilmenite carrying about 52 per cent of TiO_2. It is said that 5,804 short tons of ilmenite, carrying presumably about 52 per cent of TiO_2, was separated in 1923 from the beach sands at Pablo Beach, Fla., and shipped for the manufacture of titanium white, a pigment composed of titanium oxide with more or less of either or both calcium sulphate and barium sulphate, and for the manufacture of ferrotitanium. Corresponding figures for 1922 are 4,581 tons.

Titanium minerals produced in the United States, 1919–1923

Year	Rutile concentrates			Ilmenite concentrates		
	Short tons	Percentage of TiO_2	Value	Short tons	Percentage of TiO_2	Value
1919 [a]	102	94–96	$20,400	106	48–50	$2,120
1920	277	94–96	(b)	268	50	(b)
1921						
1922	310	95	(b)	5,181	52–54	(b)
1923	270	95	(b)	6,270	52	(b)

[a] Virginia production only; information regarding Florida not available for publication.
[b] Survey not at liberty to publish values.

IMPORTS

No titanium or "titanium steel-hardening" ores have been imported since 1918. The imports of such ores during the last six months of 1918 were 1,606 pounds, valued at $221. No separate record of similar imports was kept prior to July, 1918. Imports of "titanium potassium oxalate and all compounds and mixtures containing titanium" amounted to 39,763 pounds, valued at $6,423, in 1923 and to 82,544 pounds, valued at $20,596, from Sept. 22 to Dec. 31, 1922. Similar imports were not separately classified prior to new tariff. For imports of ferrotitanium see under Ferroalloys.

No separate record of exports of titanium, "titanium steel-hardening" ores, or ferrotitanium is kept.

TRIPOLI

[See Abrasive materials]

TUNGSTEN

PRODUCTION

No tungsten ores were mined in the United States during either 1921 or 1922, the only years in which there has been no production since 1899, and only a small production, all from Boulder Co., Colo., was made in 1923. Besides this production a small quantity of concentrates on hand from previous years was shipped by several firms.

Concentrated tungsten ores (carrying 60 per cent of tungsten trioxide), produced in the United States, sold in 1918–1923, and average value per unit

Year	Short tons	Value	Average value per unit	Year	Short tons	Value	Average value per unit
1918	5,061	$7,049,300	$23.24	1921			
1919	327	353,900	18.02	1922			
1920	216	101,800	7.86	1923	241	$144,600	$10.00

IMPORTS AND EXPORTS

The law placing a duty of 45 cents a pound on the tungsten contained in ores or concentrates, equivalent to $7.14 a short ton unit, went into effect Sept. 22, 1922, and, except for one small belated shipment, imports of ore ceased immediately. None was imported in 1923.

Tungsten-bearing ores imported for consumption in the United States, 1918–1923

Year	Short tons	Value	Year	Short tons	Value
1918	11,750	$11,552,218	1921	1,614	$276,757
1919	9,408	6,261,190	1922	1,651	279,190
1920	1,949	779,593	1923		

For imports of tungsten and ferrotungsten see under Ferroalloys.

In 1922 the following domestic exports are recorded: "Tungsten ores and concentrates (tungsten content)," 717 pounds, valued at $594. No tungsten ores of domestic production were exported in 1921, and exports for 1923 are not separately recorded.

For exports of tungsten and ferrotungsten see under Ferroalloys

PRICES

Chinese ores still dominate the world's markets. Prices in the United States ranged from $7.50 for Chinese wolframite and $8 for scheelite at the beginning of 1923 to $8.25 to $9 (depending on quality) for Chinese wolframite and $10 for scheelite at the end of the year. The price of ferrotungsten, carrying 75 to 93 per cent of tungsten, ranged from 88 to 92 cents per pound of contained tungsten. Some was forced on the market near the end of 1923 at 75 to 80 cents per pound.

URANIUM AND VANADIUM ORES

PRODUCTION

During 1923, 2,025 short tons of uranium and vanadium ores were shipped in the United States, including a large quantity of concentrate from ores rich in vanadium and lean in uranium and some chemical concentrate from roscoelite ores that had been held at Sawpit, Colo., for several years. The ores are estimated to have contained about 21.5 short tons of U_3O_8, containing 5.5 grams of radium (part of which is probably unrecoverable on account of the leanness of the ore) and 113 tons of V_2O_5 (63.3 tons of vanadium). Only a nominal value can be given to the output, possibly $150,000. During the year 12.212 grams of radium was isolated, part from residues left from work of 1922.

Four companies produced radium in 1922, and four mines were operated. The radium produced during the year amounted to 24.189 grams of radium in salts and was isolated by the Standard Chemical Co., of Pittsburgh, Pa.; the United States Radium Corporation, of New York City; the Radium Corporation of Colorado, of Denver, Colo.; and the Keystone Metals Reduction Co., of Pittsburgh. The production was only about two-thirds of the 35.693 grams isolated in 1921. In 1920 the quantity was 32.539 grams, and in 1919 it was 28.648 grams. Only 929 tons of dry ore was mined and shipped during 1922. It contained 27.35 tons of U_3O_8 (23.2 tons of uranium), 7.015 grams of radium, and 46.27 tons of V_2O_5 (25.9 tons of vanadium) and was valued at $166,016.

The output of uranium and vanadium ores in 1921 was estimated at 8,540 short tons, containing 109 tons of uranium (128.5 tons of U_3O_8), 201.5 tons of vanadium (359.9 tons of V_2O_5), and about 33 grams of radium. The approximate value, as ore, was probably about $876,000. About 35.693 grams of radium (mostly as sulphate) was isolated during the year. The output of uranium and vanadium ores in 1920 was estimated at 35,076 short tons containing 143.5 tons of uranium (169.1 tons of U_3O_8), 526.7 tons of vanadium (909.8 tons of V_2O_5), and about 43.4 grams of radium. The approximate value, as ore, was probably about $2,401,000. About 32.539 grams of

radium in various salts was isolated during the year. Any value given to the output must be arbitrary and open to question, for the larger part of the uranium ores was produced by companies that themselves used the ores.

For several years vanadium has been produced in the United States practically only as a by-product of radium production.

More than half of the world's vanadium has come from Peru, and most of the remainder from southwestern Colorado and southeastern Utah. As mining in the United States has nearly ceased, the Peruvian ores have become more preponderant.

Approximate world's production of vanadium, 1919–1923

Year	Shipments of ore from countries other than United States			Vanadium content of ore and concentrates produced in the United States (short tons)	Total (short tons)
	Short tons	Percentage of V_2O_5	Vanadium contained (short tons)		
1919	[a] 3,249	30.41	553	284	837
1920	[a] 11,158	20.43	1,277	527	1,804
1921	[a] 1,958	20.23	222	202	424
1922	818	17.18	78	26	104
1923	[a] [b] 3,513	19.8	390	63	453

[a] Peruvian ore only. During these years a little vanadium was produced in other countries, but the quantity was negligible.
[b] In 1923 the Peruvian exports include some asphaltite ash.

IMPORTS AND EXPORTS

Value of uranium salts and oxide, including radium salts, imported for consumption in the United States, 1918–1923

1918	$274	1921	$8,552
1919	12,960	1922	28,685
1920	3	1923	500,456

Vanadium ore (steel-hardening) imported for consumption in the United States, 1918–1923

Year	Pounds	Value	Year	Pounds	Value
1918—July to December [a]	1,772,215	$5,333	1921	10,307,540	$543,061
1919	6,026,005	67,846	1922	611,170	86,776
1920	20,673,296	1,080,935	1923	4,177,115	229,210

[a] Not separately classified prior to July, 1918.

Uranium-radium ore (steel-hardening) imported for consumption in the United States, 1918–1923

Year	Pounds	Value	Year	Pounds	Value
1918—July to December [a]	157	$4,840	1921	250	$446
1919			1922		
1920	396	1,110	1923		

[a] Not separately classified prior to July, 1918.

For imports of ferrovanadium see under Ferroalloys.

No separate record is kept of vanadium exports. For exports of ferrovanadium see under Ferroalloys.

PRICES

The price of vanadium in ferrovanadium during 1923 averaged about $3.50 per pound of contained vanadium in ferrovanadium carrying 35 to 45 per cent of vanadium, depending on the silicon and other impurities present. Toward the end of the year prices around $4.50 were freely mentioned. There was no real market for ores.

ZINC

SUPPLY

Supplies of primary zinc in the United States, 1919–1923, in short tons

	1919	1920	1921	1922	1923
Supply:					
Stock, Jan. 1—					
In bonded warehouses				131	80
At smelters	41,241	36,793	71,037	70,321	16,810
Production	465,743	463,377	200,500	354,277	510,434
Imports—					
Foreign	70	15	6,739	52	21
Domestic returned		8,162	731		
Total available	507,054	508,347	279,007	424,781	527,345
Withdrawn:					
Exports, foreign, from warehouse	12,256	28,132	1,256	3,471	7,080
Exports, foreign, under drawback	4,533	237	130	1,298	
Exports, domestic	129,508	85,898	3,569	30,032	45,863
Stocks, Dec. 31—					
In bonded warehouses			131	80	80
At smelters	36,793	71,037	70,321	16,810	27,808
Total withdrawn	183,090	185,304	75,407	51,691	80,831
Apparent consumption	323,964	323,043	203,600	373,090	446,514

PRODUCTION

Primary zinc produced in the United States from domestic ores, 1918–1923

Year	Short tons	Value	Year	Short tons	Value
1918	492,405	$89,618,000	1921	198,232	$19,823,000
1919	452,272	66,032,000	1922	353,274	40,273,000
1920	450,045	72,907,000	1923	508,335	69,134,000

Primary zinc produced in the United States, 1919–1923, by sources of ore, in short tons

Source	1919	1920	1921	1922	1923
United States	452,272	450,045	198,232	353,274	508,335
Foreign:					
Australia	630	2,235	133		
Canada	4,007	1,583	521	55	
Mexico	8,083	8,978	1,614	948	2,099
South America	751	536			
Total foreign	13,471	13,332	2,268	1,003	2,099
Grand total	465,743	463,377	200,500	354,277	510,434

Primary zinc produced in the United States, 1919–1923, by localities in which smelted, in short tons

Location of smelter	1919	1920	1921	1922	1923
Arkansas	31,437	31,481	15,278	13,627	29,870
Illinois	118,458	109,056	48,865	76,266	93,239
Kansas	43,942	41,044	16,573	24,167	32,006
Oklahoma	121,988	110,500	41,244	74,537	119,744
Pennsylvania	67,521	74,234	36,378	57,319	82,003
Other States	82,397	97,062	42,162	108,361	153,572
	465,743	463,377	200,500	354,277	510,434

Secondary zinc recovered as metal in the United States, 1919–1923, in short tons

	1919	1920	1921	1922	1923
Secondary zinc, redistilled	19,748	21,371	17,573	32,988	39,434
Secondary zinc, remelted	20,162	21,479	16,260	36,326	25,776
Secondary zinc recovered in alloys, excluding old brass remelted	6,062	7,650	5,840	10,250	8,630
Secondary zinc recovered in remelted brass	62,400	65,000	38,627	60,280	65,000

IMPORTS AND EXPORTS

Zinc imported for consumption in the United States, 1919–1923

Year	Blocks or pigs		Sheets		Old		Zinc dust		Manufactures	Total value
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value		
1919	32	$2,284	1	$249	37	$2,216	52	$5,753	$1,258	$11,760
1920	[a]	17	4	614	14	1,065	17	6,207	1,746	9,649
1921	6,598	559,870	6,688	496,445	6	341	42	1,121	8,290	1,066,067
1922	40	3,327	416	59,037	46	2,403	79	5,614	9,517	79,898
1923	1	375	[b]	41	20	1,624	4	891	16,331	19,262

[a] Less than 1 ton. [b] 584 pounds.

Zinc ore (zinc content) imported into the United States, 1922 and 1923, by countries[a]

[General imports]

Country	1922		1923	
	Zinc content (short tons)	Value	Zinc content (short tons)	Value
Canada	235	$8,005	4	$521
Mexico	1,665	10,971	3,201	343,649
Other countries	29	2,988	18	2,702
	1,929	21,964	3,223	346,872

[a] Ore imported duty free and containing less than 10 per cent of zinc excluded from figures by Survey as zinc content is not recovered.

Zinc exported from the United States, 1919–1923

Year	Domestic				Foreign	
	Slabs		Sheets		Slabs	
	Short tons	Value	Short tons	Value	Short tons	Value
1919	109,746	$17,524,153	19,762	$5,212,002	12,256	$1,943,507
1920	74,046	12,495,144	11,852	2,832,993	28,132	4,331,636
1921	1,753	204,984	1,816	425,618	1,256	100,677
1922	26,815	2,994,625	3,217	574,491	3,471	429,122
1923	42,131	5,961,525	3,732	764,369	7,080	941,257

Zinc exported from the United States, 1922 and 1923, by destinations

Destination	Domestic				Foreign	
	Slabs		Sheets		Slabs	
	Short tons	Value	Short tons	Value	Short tons	Value
1922						
Canada	464	$52,674	1,282	$202,149	50	$5,950
Mexico	415	49,685	375	58,977	119	15,845
France	8,282	938,978	75	13,674	784	82,306
Great Britain	7,342	793,207	593	133,405	2,021	274,335
Italy	319	33,101	2	690	196	19,665
Japan	6,060	638,867	255	31,289	224	22,175
Other countries	3,933	488,113	635	134,307	77	8,846
	26,815	2,994,625	3,217	574,491	3,471	429,122
1923						
Canada	326	56,007	908	170,341	(a)	105
Mexico	189	28,400	480	90,783	4	719
France	5,117	747,079	136	26,751	1,064	144,939
Great Britain	31,694	4,427,563	709	167,622	5,893	780,459
Italy	1,171	169,197	113	14,462	112	13,985
Japan	1	253	131	25,804		
Other countries	3,633	533,026	1,255	268,606	7	1,050
	42,131	5,961,525	3,732	764,369	7,080	941,257

(a) Less than 1 ton.

PRICES

[See statement on p. 16A]

ZINC RESIDUUM

[See Manganiferous zinc residuum]

ZIRCONIUM MINERALS

PRODUCTION

The Geological Survey has been advised that 306,750 pounds of zircon was shipped from Florida in 1923, compared with 20,100 pounds in 1922. The Survey estimates the value as $21,420 and $1,150, respectively. No production in the United States was reported to the Geological Survey from 1912 to 1921, inclusive. Brazil is the world's main producer of zirconium ores. The zirconium minerals produced in Brazil and exported consist of the silicate, zircon, and the oxide, baddeleyite.

Zirconium minerals, produced in Brazil, exported in 1918–1923

Year	Metric tons	Equivalent in short tons	Year	Metric tons	Equivalent in short tons
1918	2,141	2,360	1921	122	134
1919	208	229	1922	332	366
1920	542	597	1923	33	36

IMPORTS

Zirconium ores (steel-hardening) imported for consumption in the United States, 1918–1923

Year	Pounds	Value	Year	Pounds	Value
1918—July to December [a]	3,216,659	$77,250	1921	131,016	$3,003
1919	11,023	332	1922	67,037	4,072
1920			1923		

[a] Not separately classified prior to July, 1918.

STATE TABLES

Mineral production of Alabama in 1922 and 1923

Product	1922		1923	
	Quantity	Value	Quantity	Value
Asphalt short tons			1,200	$4,200
Barytes do	[a]	[a]	[a]	[a]
Bauxite long tons	[a]	[a]	[a]	[a]
Cement barrels	[b] 2,324,116	[b] $4,135,684	[b] 3,395,392	[b] 6,257,673
Chert short tons	63,423	20,209	[c]	[c]
Clay products		[d] 2,798,255		[d] 3,921,567
Clay, raw short tons	60,523	[e] 49,765	90,618	[e] 118,419
Coal do	18,324,740	42,856,000	20,457,649	51,624,000
Coke do	3,799,865	[e] 14,708,245	4,654,075	[e] 19,817,394
Ferroalloys long tons	[a e]	[a e]	[a e]	[a e]
Fuller's earth short tons	[a]	[a]	[a]	[a]
Gold troy ounces			6	114
Graphite, crystalline pounds	577,940	25,777	1,570,900	79,754
Iron ore long tons	5,294,520	8,791,069	6,922,663	15,540,198
Iron, pig do	2,223,159	[e] 42,883,424	2,784,625	[e] 64,912,809
Lime short tons	168,135	979,331	193,429	1,627,539
Manganese ore long tons			[a]	[a]
Manganiferous ore do	475	1,900	694	8,067
Mica:				
Scrap short tons	[a]	[a]		
Sheet pounds	[a]	[a]		
Millstones		[a]		
Mineral waters gallons sold	5,389	875	4,878	763
Sand and gravel short tons	848,743	346,920	1,829,559	760,236
Silver troy ounces			1	1
Stone short tons	[f] 863,910	[f] 828,435	[f] 1,299,160	[f] 1,401,693
Miscellaneous [g]		2,022,338		3,023,622
Total value, eliminating duplications		61,723,268		82,496,430

[a] Value included under "Miscellaneous."
[b] Exclusive of puzzolan, value for which is included under "Miscellaneous."
[c] Included under "Sand and gravel."
[d] Figures obtained through cooperation with Bureau of the Census.
[e] Value not included in total value for State.
[f] Exclusive of marble, value for which is included under "Miscellaneous."
[g] Includes minerals indicated by "[a]," "[b]," and "[f]" above.

Mineral production of Alaska in 1922 and 1923

Product	1922		1923	
	Quantity	Value	Quantity	Value
Coal short tons	79,275	$431,000	119,826	$755,000
Copper pounds	77,967,819	10,525,655	85,920,645	12,630,335
Gold troy ounces	359,057	7,422,367	289,540	5,985,314
Gypsum short tons	[a]	[a]		
Lead do	377	41,477	410	57,382
Natural gas M cubic feet			[b]	[b]
Petroleum barrels	[b]	[b]	[b]	[b]
Platinum and allied metals troy ounces	21	2,714	16	1,856
Silver do	729,945	729,945	814,649	668,012
Stone short tons	[b]	[b]	[b]	[b]
Tin (metallic equivalent) do	1	912	2	1,623
Miscellaneous [c]		352,540		141,615
Total value, eliminating duplications		19,506,610		20,241,137

[a] Calcined in Washington State. Value included under "Miscellaneous."
[b] Value included under "Miscellaneous."
[c] Includes minerals indicated by "[a]" and "[b]" above.

Mineral production of Arizona in 1922 and 1923

Product		1922		1923	
		Quantity	Value	Quantity	Value
Asbestos	short tons	[a]	[a]	4	$1,133
Clay products			[b] $123,780		[b] 102,337
Clay, raw	short tons			30	[c] 360
Copper	pounds	400,043,128	54,005,822	618,928,602	90,982,504
Feldspar (crude)	long tons			[a]	[a]
Gems and precious stones			[a]		[d]
Gold	troy ounces	170,480	3,524,134	296,109	6,121,121
Gypsum	short tons	9,319	64,625	[a]	[a]
Lead	do	7,535	828,899	8,146	1,140,408
Lime	do	[a]	[a]	18,764	264,683
Manganese ore	long tons	203	2,572	245	[a]
Pumice	short tons	[a]	[a]	10	150
Sand and gravel	do	386,854	283,600	[a]	[a]
Silica (quartz)	do			[a]	[a]
Silver	troy ounces	4,531,864	4,531,864	7,343,742	6,021,868
Stone	short tons	287,600	120,206	285,540	211,787
Sulphuric acid [e]	do	[e]	[e]	[a b c]	[a b c]
Zinc	do	105	12,006	260	35,299
Miscellaneous [f]			240,212		184,403
Total value, eliminating duplications			63,737,720		104,940,213

[a] Value included under "Miscellaneous."
[b] Figures obtained through cooperation with Bureau of the Census.
[c] Value not included in total value for State.
[d] Figures by States not available for 1923.
[e] From copper smelting. No canvass for 1922.
[f] Includes minerals indicated by "[a]" above.

Mineral production of Arkansas in 1922 and 1923

Product		1922		1923	
		Quantity	Value	Quantity	Value
Antimony ore	short tons	20	[a]	40	$800
Bauxite	long tons	266,790	$1,682,890	493,880	2,980,580
Clay products			[b c] 976,111		[b c] 1,202,857
Clay, raw	short tons	176	[d] 1,848	167	[d] 1,754
Coal	do	1,110,046	4,592,000	1,296,892	5,192,000
Fuller's earth	do	[e]	[e]		
Gems and precious stones			[f]		[f]
Gypsum	short tons	600	1,800		
Iron ore sold for magnets	long tons			10	[e]
Lead	short tons	42	4,620	25	3,500
Lime	do	11,951	115,008	14,941	136,185
Manganese ore	long tons	2,264	42,197	3,768	73,507
Manganiferous ore	do			4,773	20,047
Marl, calcareous	short tons	[c]	[c]	[c]	[c]
Mineral waters	gallons sold	248,460	28,866	723,341	60,119
Natural gas	M cubic feet	9,700,000	1,798,000	24,215,000	3,255,000
Natural-gas gasoline	gallons	4,288,955	629,491	16,183,000	1,916,000
Oilstones	short tons	[c]	[c]	[c]	[c]
Petroleum	barrels	12,712,000	20,416,000	36,610,000	25,400,000
Sand and gravel	short tons	839,773	522,121	1,572,240	826,304
Stone	do	300,970	417,729	517,050	673,197
Zinc	do	134	15,276	148	20,128
Miscellaneous [g]			176,524		194,095
Total value, eliminating duplications			31,418,633		41,954,319

[a] Ore shipped from mine, but no information regarding value.
[b] Figures obtained through cooperation with Bureau of the Census.
[c] Exclusive of pottery, value for which is included under "Miscellaneous."
[d] Value not included in total value for State.
[e] Value included under "Miscellaneous."
[f] No data available.
[g] Includes minerals indicated by "[c]" and "[e]" above.

Mineral production of California in 1922 and 1923

Product		1922		1923	
		Quantity	Value	Quantity	Value
Asbestos	short tons	[a]	[a]	65	$3,300
Asphalt	do	333,161	$4,541,999	454,407	5,052,336
Barytes	do	3,338	17,707	[a]	[a]
Borates	do	[a]	[a]	[a]	[a]
Briquets, fuel	do	[a b]	[a b]	[a b]	[a b]
Calcium chloride	do			704	14,083
Cement	barrels	9,041,788	20,478,577	10,882,802	26,022,156
Chromite	long tons	163	3,354	69	1,415
Clay products			[c] 14,689,830		[c] 20,833,053
Clay, raw	short tons	206,740	[b] 396,201	281,893	[b] 453,754
Coal	do	[a]	[a]	[a]	[a]
Copper	pounds	22,539,485	3,042,830	28,317,759	4,162,711
Diatomaceous earth	short tons	[a]	[a]	58,980	619,173
Feldspar (crude)	long tons	2,378	17,510	9,297	62,499
Gems and precious stones			[a]		[d]
Gold	troy ounces	709,678	14,670,346	647,210	13,379,013
Graphite, crystalline	pounds	[a]	[a]		
Gypsum	short tons	[a]	[a]	111,832	670,495
Iron ore:					
Sold to furnaces	long tons	3,204	18,868	2,769	18,665
Sold for paint	do			10	[a]
Lead	short tons	3,156	347,189	4,775	668,478
Lime	do	55,161	683,774	66,703	869,979
Lithium minerals	do	[a]	[a]		
Magnesite	do	55,610	569,900	73,350	938,600
Magnesium chloride (natural)	pounds	[e]	[e]	5,728,879	74,064
Magnesium sulphate (natural)	do	[e]	[e]	[a]	[a]
Manganese ore	long tons	[a]	[a]	[a]	[a]
Marl, calcareous	short tons	16,231	75,109	18,303	109,437
Mineral paints, zinc and lead pigments	do	[a b]	[a b]		
Mineral waters	gallons sold	3,048,324	433,711	7,275,735	664,621
Natural gas	M cubic feet	84,580,000	17,898,000	131,434,000	22,787,000
Natural-gas gasoline	gallons	67,119,700	11,868,152	173,329,000	16,564,000
Oil from shale	do			160,000	[e]
Peat	short tons	10,988	115,943	8,133	73,799
Pebbles for grinding	do	[a]	[a]	[a]	[a]
Petroleum	barrels	138,468,000	173,381,000	262,876,000	242,731,000
Platinum and allied metals	troy ounces	782	140,358	292	39,355
Potash (K_2O)	short tons	10,102	393,953	19,000	766,138
Pumice	do			431	6,289
Pyrites	long tons	[a]	[a]	[a]	[a]
Quicksilver	flasks	3,405	196,741	5,447	357,759
Salt	short tons	257,790	1,211,197	252,465	1,327,917
Sand and gravel	do	5,946,892	4,033,856	7,205,516	5,033,457
Sand-lime brick	thousands			[a c]	[a c]
Silica (quartz)	short tons	240	1,984	4,465	25,649
Silver	troy ounces	3,100,065	3,100,065	3,559,443	2,918,743
Slate					[a]
Sodium salts (carbonate, bicarbonate, sulphate, and trona) from natural sources	short tons	33,537	690,021	39,600	809,050
Stone	do	5,521,690	6,879,002	7,623,470	8,905,584
Talc	do	12,638	187,011	16,144	224,838
Zinc	do	1,506	171,738		
Miscellaneous [f]			3,945,647		4,395,598
Total value, eliminating duplications			283,411,997		381,010,424

[a] Value included under "Miscellaneous."
[b] Value not included in total value for State.
[c] Figures obtained through cooperation with Bureau of the Census.
[d] Figures by States not available for 1923.
[e] No data available.
[f] Includes minerals indicated by "a" above.

Mineral production of Colorado in 1922 and 1923

Product		1922		1923	
		Quantity	Value	Quantity	Value
Cement	barrels	[a]	[a]	[a]	[a]
Clay products			[b] $3,431,197		[b] $4,413,602
Clay, raw	short tons	148,450	[c] 158,621	190,250	[c] 272,276
Coal	do	10,019,597	31,701,000	10,346,218	33,299,000
Coke	do	484,039	[a e]	647,823	[a c]
Copper	pounds	3,373,454	455,416	4,248,109	624,472
Feldspar (crude)	long tons	104	580	[a]	[a]
Ferroalloys	do	[a c]	[a c]	[a c]	[a c]
Fluorspar	short tons	2,309	20,169	6,044	59,710
Gems and precious stones			[a]		[d]
Gold	troy ounces	308,314	6,373,419	318,870	6,591,629
Gypsum	short tons	[a]	[a]	[a]	[a]
Iron ore	long tons	513	[a]	4,102	[a]
Iron, pig	do	[a c]	[a c]	[a c]	[a c]
Lead	short tons	11,739	1,291,246	22,849	3,198,873
Lime	do	[a]	[a]	[a]	[a]
Manganese ore	long tons			2,278	41,203
Manganiferous ore:					
For fluxing	do	13,951	[a]	10,376	25,940
For other purposes	do			18,348	68,204
Mica, scrap	short tons	[a]	[a]	[a]	[a]
Mineral paints, zinc and lead pigments	do	[a c]	[a c]	14,562	[c] 1,798,112
Mineral waters	gallons sold	146,626	55,283	171,089	55,072
Natural gas	M cubic feet	4,000	560	800	400
Petroleum	barrels	97,000	114,000	86,000	102,000
Potash (K_2O)	short tons	[a]	[a]		
Pyrites (radio crystals)	pounds			[d]	[d]
Sand and gravel	short tons	139,365	114,651	185,994	126,967
Silver	troy ounces	5,855,911	5,855,911	5,334,488	4,374,280
Stone	short tons	[e] 427,880	[e] 555,694	[e] 543,480	[e] 749,798
Tungsten ore (60 per cent concentrates)	do			241	144,600
Uranium and vanadium ores	do	591	73,875	[a]	[a]
Zinc	do	11,629	1,325,706	27,076	3,682,336
Miscellaneous [f]			12,850,466		15,539,934
Total value, eliminating duplications			54,806,277		61,379,146

[a] Value included under "Miscellaneous."
[b] Figures obtained through cooperation with Bureau of the Census.
[c] Value not included in total value for State.
[d] Figures not available.
[e] Exclusive of marble, value for which is included under "Miscellaneous."
[f] Includes minerals indicated by "a" and "e" above.

Mineral production of Connecticut in 1922 and 1923

Product		1922		1923	
		Quantity	Value	Quantity	Value
Clay products			[a b] $2,379,023		[a b] $3,665,174
Clay, raw	short tons	[c d]	[c d]	703	[c] 1,139
Feldspar (crude)	long tons	7,499	47,887	8,780	75,379
Iron, pig	do	[c d]	[c d]		
Lime	short tons	52,108	743,742	59,158	813,254
Mica:					
Scrap	do	[d]	[d]	[d]	[d]
Sheet	pounds	[d]	[d]	[d]	[d]
Mineral waters	gallons sold	1,141,421	70,926	1,077,195	63,732
Sand and gravel	short tons	325,498	199,260	691,039	303,443
Silica (quartz)	do	2,129	11,177	3,264	15,987
Stone	do	[e] 1,420,710	[e] 1,585,461	1,482,710	1,830,413
Miscellaneous [f]			352,908		409,884
Total value, eliminating duplications			5,346,295		7,177,266

[a] Figures obtained through cooperation with Bureau of the Census.
[b] Exclusive of pottery, value for which is included under "Miscellaneous."
[c] Value not included in total value for State.
[d] Value included under "Miscellaneous."
[e] Exclusive of sandstone, value for which is included under "Miscellaneous."
[f] Includes minerals indicated by "b," "d," and "e" above.

Mineral production of Delaware in 1922 and 1923

Product	1922		1923	
	Quantity	Value	Quantity	Value
Clay products		[a] $219,633		[a] $249,804
Clay, raw, short tons	4,203	[b] 26,508	5,282	[b] 29,400
Sand and gravel, do	32,492	30,561	53,022	34,113
Stone, do	[c]	[c]	84,440	132,157
Miscellaneous		178,120		
Total value, eliminating duplications		428,314		416,074

[a] Figures obtained through cooperation with Bureau of the Census.
[b] Value not included in total value for State.
[c] Value included under "Miscellaneous."

Mineral production of the District of Columbia in 1922 and 1923

Product	1922		1923	
	Quantity	Value	Quantity	Value
Clay products		[a b] $235,453		[a b] $242,980
Ferroalloys, long tons	[c d]	[c d]	[c d]	[c d]
Sand and gravel, short tons	[c]	[c]	[c]	[c]
Sand-lime brick, thousands	[e]	[e]	[a c]	[a c]
Stone, short tons	11,110	18,658	7,470	20,576
Miscellaneous [f]		678,221		773,567
Total value, eliminating duplications		869,132		929,768

[a] Figures obtained through cooperation with Bureau of the Census.
[b] Exclusive of pottery, value for which is included under "Miscellaneous."
[c] Value included under "Miscellaneous."
[d] Value not included in total value for State.
[e] No canvass for 1922.
[f] Includes minerals indicated by "[b]" and "[c]" above.

Mineral production of Florida in 1922 and 1923

Product	1922		1923	
	Quantity	Value	Quantity	Value
Clay products		[a b] $174,578		[a b] $214,157
Clay, raw, short tons	[c d]	[c d]	[c d]	[c d]
Fuller's earth, do	64,122	1,122,940	60,996	973,121
Ilmenite, do	4,581	91,620	5,804	[e] 116,080
Lime, do	[d]	[d]	[d]	[d]
Mineral waters, gallons sold	1,004,984	57,305	1,697,197	131,781
Peat, short tons	500	2,500	14	170
Phosphate rock, long tons	2,058,593	8,347,522	2,547,653	9,059,427
Sand and gravel, short tons	246,849	147,924	513,245	290,082
Sand-lime brick, thousands	[f]	[f]	[a d]	[a d]
Stone, short tons	[g] 770,140	[g] 706,644	1,494,080	1,425,434
Zircon, do	10	[e] 1,150	153	[e] 21,420
Miscellaneous [h]		770,501		989,687
Total value, eliminating duplications		10,907,718		12,557,822

[a] Figures obtained through cooperation with Bureau of the Census.
[b] Exclusive of pottery, value for which is included under "Miscellaneous."
[c] Value not included in total value for State.
[d] Value included under "Miscellaneous."
[e] Value estimated.
[f] No canvass for 1922.
[g] Exclusive of flinty limestone, value for which is included under "Miscellaneous."
[h] Includes minerals indicated by "[b]," "[d]," and "[g]" above.

Mineral production of Georgia in 1922 and 1923

Product	1922		1923	
	Quantity	Value	Quantity	Value
Asbestos short tons			150	$1,350
Barytes do	57,045	$468,517	83,291	670,343
Bauxite long tons	30,420	231,250	22,553	141,975
Cement barrels	[a]	[a]	[a]	[a]
Clay products		[b] 4,157,601		[b] 5,739,128
Clay, raw short tons	233,828	[c] 850,072	319,021	[c] 1,077,196
Coal do	60,636	246,000	75,620	327,000
Coke do	8,832	[c] 74,807	12,556	[c] 126,690
Copper pounds	6,000	810		
Fuller's earth short tons	58,810	983,534	[a]	[a]
Gold troy ounces	156	3,224	26	529
Iron ore long tons	28,566	77,636	117,286	300,712
Lead short tons	4	440		
Lime do	[a]	[a]	[a]	[a]
Manganese ore long tons			1,502	23,380
Manganiferous ore do	1,033	[a]	30,248	123,846
Mica:				
Scrap short tons	224	7,247	[a]	[a]
Sheet pounds	8,818	4,083	[a]	[a]
Mineral waters gallons sold	424,290	36,856	637,907	58,810
Sand and gravel short tons	461,359	191,420	595,117	300,621
Sand-lime brick thousands	[d]	[d]	[a b]	[a b]
Silver troy ounces	364	364	2	1
Slate		[a]		[a]
Stone short tons	444,590	3,349,293	563,910	3,942,294
Talc do	1,506	40,042	796	16,568
Miscellaneous [e]		1,321,701		2,653,756
Total value, eliminating duplications		11,120,018		14,300,313

[a] Value included under "Miscellaneous."
[b] Figures obtained through cooperation with Bureau of the Census.
[c] Value not included in total value for State.
[d] No canvass for 1922.
[e] Includes minerals indicated by "[a]" above.

Mineral production of Idaho in 1922 and 1923

Product	1922		1923	
	Quantity	Value	Quantity	Value
Barytes short tons	[a]	[a]		
Clay products		[b] $128,259		[b] $135,920
Clay, raw short tons	394	[c] 2,410	133	[c] 1,297
Coal do	[a]	[a]	[a]	[a]
Copper pounds	3,282,842	443,184	3,979,631	585,006
Gems and precious stones		[a]		[d]
Gold troy ounces	24,255	501,405	37,124	767,427
Iron ore long tons	25	[a]	1,290	[a]
Lead short tons	97,917	10,770,881	121,178	16,964,901
Lime do	[a]	[a]	[a]	[a]
Phosphate rock long tons	4,481	19,692	30,085	174,713
Platinum and allied metals troy ounces	7	857		
Pumice short tons			[a]	[a]
Quicksilver flasks			[a]	[a]
Salt short tons	21	240	31	310
Sand and gravel do	79,651	38,775	97,044	43,039
Silver troy ounces	6,081,865	6,081,865	7,673,662	6,292,403
Stone short tons	166,650	235,241	175,050	205,486
Zinc do	2,055	234,220	13,976	1,900,787
Miscellaneous [e]		41,009		35,352
Total value, eliminating duplications		18,495,628		27,105,344

[a] Value included under "Miscellaneous."
[b] Figures obtained through cooperation with Bureau of the Census.
[c] Value not included in total value for State.
[d] Figures by States not available for 1923.
[e] Includes minerals indicated by "[a]" above.

Mineral production of Illinois in 1922 and 1923

Product		1922		1923	
		Quantity	Value	Quantity	Value
Asphalt	short tons	167,030	$1,794,554	152,009	$2,809,015
Barytes	do	[a]	[a]		
Cement	barrels	[b] 6,554,945	[b] 10,584,171	[b] 7,129,208	[b] 12,550,100
Clay products			[c] 26,784,263		[c] 34,218,987
Clay, raw	short tons	130,323	[d] 242,487	165,895	[d] 313,919
Coal	do	58,467,736	168,925,000	79,310,075	198,388,000
Coke	do	1,982,906	[d] 18,164,549	3,187,168	[d] 30,373,638
Ferroalloys	long tons	[a d]	[a d]	[a d]	[a d]
Fluorspar	short tons	83,855	1,493,188	65,045	1,443,490
Fuller's earth	do	[a]	[a]	[a]	[a]
Iron, pig	long tons	2,729,172	[d] 58,954,675	3,741,002	[d] 94,878,917
Lead	short tons	1,325	145,750	1,381	193,340
Lime	do	85,425	860,945	92,633	978,658
Mineral paints, zinc and lead pigments	do	[a d]	[a d]	13,657	[d] 2,048,506
Mineral waters	gallons sold	335,974	18,679	390,578	14,648
Natural gas	M cubic feet	3,383,000	424,040	4,049,000	690,000
Natural-gas gasoline	gallons	7,760,011	1,181,797	7,356,009	851,000
Peat	short tons	[a]	[a]	[a]	[a]
Petroleum	barrels	9,383,000	19,291,000	8,707,000	16,250,000
Sand and gravel	short tons	8,840,293	5,411,821	11,951,045	7,460,738
Sand and sandstone (finely ground)	do	66,792	378,729	78,042	480,302
Sand-lime brick	thousands	[e]	[e]	[a c]	[a c]
Silver	troy ounces	6,025	6,025	8,170	6,699
Stone	short tons	6,781,310	6,473,566	9,111,830	8,358,556
Sulphuric acid (60° Baumé) [f]	do	[e]	[e]	[c] 237,795	[c d] 2,128,687
Tripoli	do	18,747	194,371	11,522	117,201
Zinc	do	3,124	356,136	1,266	172,176
Miscellaneous [g]			1,577,130		787,785
Total value, eliminating duplications			244,617,561		285,569,638

[a] Value included under "Miscellaneous."
[b] Exclusive of natural cement, value for which is included under "Miscellaneous."
[c] Figures obtained through cooperation with Bureau of the Census.
[d] Value not included in total value for State.
[e] No canvass for 1922.
[f] From zinc smelting.
[g] Includes minerals indicated by "[a]" and "[b]" above.

Mineral production of Indiana in 1922 and 1923

Product		1922		1923	
		Quantity	Value	Quantity	Value
Asphalt	short tons	[a]	[a]	[a]	[a]
Cement	barrels	[a]	[a]	[a]	[a]
Clay products			[b] $13,942,139		[b] $15,643,128
Clay, raw	short tons	45,446	[c] 74,288	80,227	[c] 151,243
Coal	do	19,132,889	54,524,000	26,229,099	65,046,000
Coke	do	3,995,505	[c] 28,978,431	5,042,614	[c] 46,765,264
Iron, pig	long tons	2,191,356	[c] 43,064,817	3,021,504	[c] 70,270,894
Lime	short tons	113,246	938,645	126,296	1,151,083
Mineral paints, zinc and lead pigments	do	[a c]	[a c]	[a c]	[a c]
Mineral waters	gallons sold	514,211	156,358	500,064	152,082
Natural gas	M cubic feet	947,000	476,172	880,000	460,000
Oilstones and scythestones	short tons	445	43,637	484	47,193
Peat	do			[a]	[a]
Petroleum	barrels	1,087,000	2,225,000	1,043,000	1,900,000
Potash (K_2O)	short tons			1	225
Sand and gravel	do	5,824,330	2,977,008	10,918,278	4,990,506
Sand-lime brick	thousands	[d]	[d]	[a b]	[a b]
Stone	short tons	2,775,740	13,203,146	3,650,110	17,692,112
Miscellaneous [e]			19,975,090		26,024,564
Total value, eliminating duplications			108,394,095		132,179,525

[a] Value included under "Miscellaneous."
[b] Figures obtained through cooperation with Bureau of the Census.
[c] Value not included in total value for State.
[d] No canvass for 1922.
[e] Includes minerals indicated by "[a]" above.

Mineral production of Iowa in 1922 and 1923

Product		1922		1923	
		Quantity	Value	Quantity	Value
Cement	barrels	4,475,074	$7,709,313	5,570,675	$10,351,971
Clay products			[a] [b] 5,739,449		[a] [b] 6,920,336
Clay, raw	short tons	22,887	[c] 23,068	4,666	[c] 4,730
Coal	do	4,335,161	16,119,000	5,710,735	20,517,000
Ferroalloys	long tons	[c] [d]	[c] [d]	[c] [d]	[c] [d]
Gypsum	short tons	536,905	4,146,182	685,041	5,368,532
Lime	do	[d]	[d]	[d]	[d]
Mineral waters	gallons sold	25,561	3,788	45,072	8,907
Natural gas	M cubic feet	500	250	[d]	[d]
Sand and gravel	short tons	2,690,798	1,752,233	3,597,160	2,181,881
Sand-lime brick	thousands	[e]	[e]	[a] [d]	[a] [d]
Stone	short tons	620,810	657,161	[f] 603,550	[f] 698,207
Miscellaneous [g]			607,499		744,706
Total value, eliminating duplications			36,205,251		46,174,897

[a] Figures obtained through cooperation with Bureau of the Census.
[b] Exclusive of pottery, value for which is included under "Miscellaneous."
[c] Value not included in total value for State.
[d] Value included under "Miscellaneous."
[e] No canvass for 1922.
[f] Exclusive of sandstone, value for which is included under "Miscellaneous."
[g] Includes minerals indicated by "[b]", "[d]", and "[f]" above.

Mineral production of Kansas in 1922 and 1923

Product		1922		1923	
		Quantity	Value	Quantity	Value
Asphalt	short tons	[a]	[a]	[a]	[a]
Cement	barrels	[b] 4,556,517	[b] $8,138,268	[b] 5,878,839	[b] $10,868,590
Clay products			[c] 3,715,819		[c] 4,425,067
Coal	short tons	2,955,170	10,816,000	4,443,149	14,275,000
Gypsum	do	105,481	690,740	135,019	842,740
Lead	do	23,271	2,559,810	17,598	2,463,720
Mineral paints, zinc and lead pigments	do	[a] [d]	[a] [d]	[a] [d]	[a] [d]
Mineral waters	gallons sold	383,600	64,554	494,048	77,935
Natural gas	M cubic feet	20,289,000	9,123,000	32,072,000	11,304,000
Natural-gas gasoline	gallons	2,855,573	435,056	8,775,000	690,000
Petroleum	barrels	31,766,000	56,131,000	28,250,000	45,970,000
Pumice	short tons	[a]	[a]	51,907	170,459
Salt	do	759,459	3,849,427	845,163	3,570,135
Sand and gravel	do	1,398,996	790,763	1,950,411	1,039,064
Stone	do	657,660	895,476	919,640	1,180,397
Zinc	do	56,225	6,409,650	100,969	13,731,784
Miscellaneous [e]			1,444,763		1,213,134
Total value, eliminating duplications			103,884,561		110,685,713

[a] Value included under "Miscellaneous."
[b] Exclusive of natural cement, value for which is included under "Miscellaneous."
[c] Figures obtained through cooperation with Bureau of the Census.
[d] Value not included in total value for State.
[e] Includes minerals indicated by "[a]" and "[b]" above.

Mineral production of Kentucky in 1922 and 1923

Product	1922		1923	
	Quantity	Value	Quantity	Value
Asphalt short tons	[a]	[a]	184,300	$1,468,396
Barytes do			[a]	[a]
Cement barrels	[a]	[a]	[a]	[a]
Clay products		[b c] $4,986,502		[b] 7,610,179
Clay, raw short tons	67,591	[d] 270,858	102,195	[d] 428,021
Coal do	42,134,175	127,037,000	44,777,317	113,542,000
Coke do	487,167	[d] 3,614,140	559,711	[a d]
Fluorspar do	52,484	970,059	45,441	945,402
Iron, pig long tons	140,217	[d] 2,951,627	154,680	[a d]
Lead short tons	92	10,120	53	7,420
Lime do	1,560	11,062	[a]	[a]
Mineral waters gallons sold	191,275	30,430	210,367	33,050
Natural gas M cubic feet	5,872,000	1,879,000	11,953,000	3,156,000
Natural-gas gasoline gallons	5,204,883	925,810	7,601,000	1,067,000
Oilstones short tons	[a]	[a]	[a]	[a]
Petroleum barrels	8,973,200	17,758,000	8,069,000	15,900,000
Phosphate rock long tons	[a]	[a]	[a]	[a]
Sand and gravel short tons	1,517,759	937,649	2,101,840	1,279,441
Stone do	1,537,690	1,853,851	1,884,380	2,250,025
Zinc do	142	16,188	270	36,720
Miscellaneous [e]		2,285,825		10,004,567
Total value, eliminating duplications		158,701,496		148,853,786

[a] Value included under "Miscellaneous."
[b] Figures obtained through cooperation with Bureau of the Census.
[c] Exclusive of pottery, value for which is included under "Miscellaneous."
[d] Value not included in total value for State.
[e] Includes minerals indicated by "[a]" and "[c]" above.

Mineral production of Louisiana in 1922 and 1923

Product	1922		1923	
	Quantity	Value	Quantity	Value
Clay products		[a b] $578,615		[a b] $731,252
Mineral waters gallons sold	[c]	[c]	[c]	[c]
Natural gas M cubic feet	70,267,000	5,849,000	112,031,000	6,022,000
Natural-gas gasoline gallons	29,406,282	4,112,655	40,720,000	3,484,000
Petroleum barrels	35,376,000	53,169,000	24,919,000	36,530,000
Salt short tons	336,852	1,657,708	359,161	1,808,762
Sand and gravel do	1,711,292	1,106,807	2,905,609	1,926,917
Sand-lime brick thousands	[d]	[d]	[a c]	[a c]
Stone short tons	[c]	[c]	[c]	[c]
Sulphur long tons	[c]	[c]	[c]	[c]
Miscellaneous [e]		9,045,543		10,696,117
Total value, eliminating duplications		75,519,328		61,199,048

[a] Figures obtained through cooperation with Bureau of the Census.
[b] Exclusive of pottery, value for which is included under "Miscellaneous."
[c] Value included under "Miscellaneous."
[d] No canvass for 1922.
[e] Includes minerals indicated by "[b]" and "[c]" above.

Mineral production of Maine in 1922 and 1923

Product	1922		1923	
	Quantity	Value	Quantity	Value
Clay products		[a] $768,725		[a] $877,555
Feldspar (crude) long tons	21,692	221,478	25,029	230,122
Gems and precious stones		[b]		[c]
Lime short tons	127,840	1,757,480	139,781	1,946,486
Millstones				2,350
Mineral waters gallons sold	928,149	368,939	973,442	415,353
Peat short tons	[b]	[b]	14	560
Sand and gravel do	100,179	102,901	531,937	169,905
Slate		464,713		754,826
Stone short tons	191,760	1,903,084	306,620	3,168,396
Miscellaneous [d]		820		
Total value, eliminating duplications		5,588,140		7,565,553

[a] Figures obtained through cooperation with Bureau of the Census.
[b] Value included under "Miscellaneous."
[c] Figures by States not available for 1923.
[d] Includes minerals indicated by "[b]" above.

Mineral production of Maryland in 1922 and 1923

Product	1922		1923	
	Quantity	Value	Quantity	Value
Asbestos short tons	(a)	(a)	8	$3,843
Cement barrels	(a)	(a)	(a)	(a)
Chromite long tons	113	$3,302	80	1,840
Clay products		[b] 3,596,004		[b] 4,909,498
Clay, raw short tons	72,749	[c] 147,969	87,277	[c] 172,169
Coal do	1,222,707	4,122,000	2,285,926	6,911,000
Coke do	589,893	(a c)	861,668	(a c)
Diatomaceous earth do	(a)	(a)	50	825
Feldspar (crude) long tons	2,899	18,099	2,750	17,010
Ferroalloys do	(a c)	(a c)	(a c)	(a c)
Iron, pig do	423,533	(a c)	489,137	(a c)
Lime short tons	71,261	554,194	63,858	553,811
Marl, calcareous do	100	450	610	2,501
Mineral waters gallons sold	749,624	73,890	874,689	88,568
Sand and gravel short tons	1,586,915	1,606,376	2,044,490	2,155,353
Silica (quartz) do	(a)	(a)	2,119	42,125
Slate		(a)		(a)
Stone short tons	997,260	1,435,923	1,244,010	2,054,125
Talc do	1,667	14,667	580	25,500
Miscellaneous [d]		16,907,766		25,719,638
Total value, eliminating duplications		14,905,227		21,189,542

[a] Value included under "Miscellaneous."
[b] Figures obtained through cooperation with Bureau of the Census.
[c] Value not included in total value for State.
[d] Includes minerals indicated by "[a]" above.

Mineral production of Massachusetts in 1922 and 1923

Product	1922		1923	
	Quantity	Value	Quantity	Value
Clay products		[a] $2,502,614		[a] $4,194,855
Clay, raw short tons	1,012	[b] 3,941	1,358	[b] 6,856
Coke do	407,081	(b c)	554,125	(b c)
Fuller's earth do	(c)	(c)	(c)	(c)
Iron ore long tons	4,368	(c)		
Iron, pig do	510	(b c)	1,667	(b c)
Lime short tons	164,980	2,510,368	180,720	2,550,575
Mineral waters gallons sold	1,417,111	81,674	1,958,556	110,305
Peat short tons	(c)	(c)	(c)	(c)
Sand and gravel do	1,600,581	1,499,170	1,813,715	1,821,116
Sand and sandstone (finely ground) do	(c)	(c)	(c)	(c)
Sand-lime brick thousands	(d)	(d)	(a c)	(a c)
Stone short tons	1,607,970	4,375,387	1,788,860	5,794,941
Miscellaneous [e]		5,988,442		6,978,137
Total value, eliminating duplications		11,004,523		14,781,129

[a] Figures obtained through cooperation with Bureau of the Census.
[b] Value not included in total value for State.
[c] Value included under "Miscellaneous."
[d] No canvass for 1922.
[e] Includes minerals indicated by "[c]" above.

Mineral production of Michigan in 1922 and 1923

Product		1922		1923	
		Quantity	Value	Quantity	Value
Bromine	pounds	(a)	(a)	(a)	(a)
Calcium chloride	short tons	24,998	$488,404	32,669	$578,462
Cement	barrels	6,349,751	11,145,573	7,466,283	14,038,322
Clay products			[b] 4,296,213		[b] 6,959,278
Clay, raw	short tons	1,653	[c] 4,852	3,617	[c] 7,327
Coal	do	929,390	4,693,000	1,172,075	5,545,000
Coke	do	1,142,059	[c] 9,229,083	1,648,773	[c] 14,389,742
Copper	pounds	121,712,365	16,431,169	158,304,080	20,330,700
Gems and precious stones			(a)		(d)
Graphite, amorphous	short tons			856	(a)
Grindstones	do	(a)	(a)	(a)	(a)
Gypsum	do	471,355	2,843,117	586,987	3,252,993
Iron ore:					
Sold to furnaces	long tons	12,457,856	43,449,513	14,065,561	54,110,070
Sold for paint	do	3,971	(a)	4,377	(a)
Iron, pig	do	595,647	[c] 14,791,041	717,279	[c] 18,827,808
Lime	short tons	53,635	484,945	59,629	612,369
Magnesium	pounds	(e)	(e)	(a f)	(a f)
Magnesium chloride (natural)	do	(e)	(e)	(a f)	(a f)
Magnesium sulphate (natural)	do	(e)	(e)	(a)	(a)
Manganiferous ore	long tons	9,644	(a)	224,779	(a)
Marl, calcareous	short tons			2,000	3,000
Mineral waters	gallons sold	1,229,802	150,237	1,478,135	164,968
Natural gas	M cubic feet	700	350	700	320
Peat	short tons	1,792	26,248	(a)	(a)
Salt	do	2,005,088	8,693,604	2,127,412	8,684,148
Sand and gravel	do	5,962,916	3,222,043	9,601,562	5,096,071
Sand-lime brick	thousands	(h)	(h)	[b] 65,162	[b] 783,271
Silver	troy ounces	376,990	376,990	223,997	183,678
Stone	short tons	[i] 7,741,110	[i] 4,910,786	[i] 10,715,910	[i] 6,303,136
Miscellaneous [j]			218,789		1,645,664
Total value, eliminating duplications			101,430,981		128,291,450

[a] Value included under "Miscellaneous."
[b] Figures obtained through cooperation with Bureau of the Census.
[c] Value not included in total value for State.
[d] Figures by States not available for 1923.
[e] Information withheld by producer.
[f] Partly estimated.
[g] No data available.
[h] No canvass for 1922.
[i] Exclusive of sandstone in 1922 and of serpentine in 1923, value for which is included under "Miscellaneous."
[j] Includes minerals indicated by "a" and "i" above.

Mineral production of Minnesota in 1922 and 1923

Product		1922		1923	
		Quantity	Value	Quantity	Value
Cement	barrels	(a)	(a)	(a)	(a)
Clay products			[b c] $2,201,502		[b c] $2,031,408
Clay, raw	short tons	19,078	[d] 25,287	(a d)	(a d)
Coke	do	462,044	[d] 4,641,871	695,824	[d] 5,104,330
Flint lining for tube mills	do	(a)	(a)	(a)	(a)
Gems and precious stones			(a)		(e)
Iron ore	long tons	30,209,372	98,903,398	44,556,053	158,402,788
Iron, pig	do	177,297	(a d)	418,726	(a d)
Lime	short tons	27,670	307,270	29,805	339,957
Manganiferous ore	long tons	553,653	1,562,589	752,815	2,286,960
Marl, calcareous	short tons			150	263
Millstones					(a)
Mineral waters	gallons sold	2,962,160	156,066	1,806,292	136,855
Pebbles for grinding	short tons	(a)	(a)	(a)	(a)
Sand and gravel	do	1,900,532	1,332,567	3,826,472	2,184,106
Sand-lime brick	thousands	(f)	(f)	(a b)	(a b)
Stone	short tons	656,970	3,163,716	701,210	4,281,687
Miscellaneous [g]			8,024,399		15,036,262
Total value, eliminating duplications			111,617,448		174,105,328

[a] Value included under "Miscellaneous."
[b] Figures obtained through cooperation with Bureau of the Census.
[c] Exclusive of pottery, value for which is included under "Miscellaneous."
[d] Value not included in total value for State.
[e] Figures by States not available for 1923.
[f] No canvass for 1922.
[g] Includes minerals indicated by "a" and "c" above.

Mineral production of Mississippi in 1922 and 1923

Product	1922		1923	
	Quantity	Value	Quantity	Value
Clay products		[a] $691,779		[a b] $878,684
Clay, raw short tons	1,080	[c] 2,160	2,059	[c] 11,380
Mineral waters gallons sold	100,548	25,966	93,441	23,379
Sand and gravel short tons	1,787,497	881,483	2,772,149	1,229,809
Stone do	[d]	[d]	[d]	[d]
Miscellaneous		1,165		31,471
Total value, eliminating duplications		1,600,393		2,163,343

[a] Figures obtained through cooperation with Bureau of the Census.
[b] Exclusive of pottery, value for which is included under "Miscellaneous."
[c] Value not included in total value for State.
[d] Value included under "Miscellaneous."

Mineral production of Missouri in 1922 and 1923

Product	1922		1923	
	Quantity	Value	Quantity	Value
Barytes short tons	66,421	$421,568	81,701	$629,097
Briquets, fuel do	[a b]	[a b]	[a b]	[a b]
Cement barrels	6,239,144	10,457,557	7,143,883	13,237,141
Chats short tons	1,141,159	[c] 175,000	1,218,180	[c] 185,000
Clay products		[d] 11,746,008		[d] 17,903,774
Clay, raw short tons	412,128	[b] 1,238,622	495,797	[b] 1,624,789
Coal do	2,924,750	11,153,000	3,403,151	11,575,000
Coke do	[a b]	[a b]	[a b]	[a b]
Copper pounds	797,400	107,649	202,556	29,776
Iron ore:				
Sold to furnaces long tons	58,320	244,928	54,348	247,975
Sold for paint do	38	[a]		
Iron, pig do	7,700	[a b]	4,513	[a b]
Lead short tons	178,412	19,625,320	169,743	23,764,020
Lime do	203,984	1,953,524	246,326	2,505,785
Mineral paints, zinc and lead pigments do	[a b]	[a b]	[a b]	[a b]
Mineral waters gallons sold	141,369	40,149	174,636	38,145
Natural gas M cubic feet	2,600	2,028	17,000	12,000
Petroleum barrels	[a]	[a]	[a]	[a]
Sand and gravel short tons	1,970,345	1,062,370	3,719,243	2,007,529
Silver troy ounces	212,656	212,656	177,270	145,361
Stone short tons	1,611,020	3,322,672	2,134,910	4,345,526
Tripoli do	[a]	[a]	[a]	[a]
Zinc do	16,171	1,843,494	18,265	2,484,040
Miscellaneous [e]		3,427,464		4,511,639
Total value, eliminating duplications		62,402,642		79,199,473

[a] Value included under "Miscellaneous."
[b] Value not included in total value for State.
[c] Value estimated.
[d] Figures obtained through cooperation with Bureau of the Census.
[e] Includes minerals indicated by "[a]" above.

Mineral production of Montana in 1922 and 1923

Product		1922		1923	
		Quantity	Value	Quantity	Value
Arsenious oxide	short tons	[a]	[a]	3,492	$279,376
Cement	barrels	[b]	[b]	[b]	[b]
Clay products			[c] $290,781		[c] 312,219
Clay, raw	short tons	7,363	[d] 11,416	11,624	[d] 20,033
Coal	do	2,572,221	8,208,500	3,147,678	9,652,000
Copper	pounds	165,754,442	22,376,850	224,125,264	32,946,414
Ferroalloys	long tons	[b d]	[b d]	[b d]	[b d]
Gems and precious stones			[b]		[e]
Gold	troy ounces	80,146	1,656,757	85,079	1,758,748
Gypsum	short tons	[b]	[b]	[b]	[b]
Iron ore	long tons	21,726	59,566	17,751	51,039
Lead	short tons	14,884	1,637,211	17,973	2,516,194
Lime	do	[b]	[b]	[b]	[b]
Manganese ore:					
For fluxing	long tons	2,278	17,341	769	[b]
For other purposes	do	9,751	371,245	21,916	674,509
Manganiferous ore (for fluxing)	do	6,656	28,000	2,827	[b]
Mineral waters	gallons sold	[b]	[b]	[b]	[b]
Natural gas	M cubic feet	486,000	88,300	1,470,000	317,000
Petroleum	barrels	2,449,000	4,048,000	2,782,000	4,080,000
Sand and gravel	short tons	79,604	56,119	365,303	156,057
Silver	troy ounces	12,468,151	12,468,151	13,380,862	10,972,307
Stone	short tons	[f] 184,010	[f] 211,293	[f] 275,900	[f] 270,781
Zinc	do	59,535	6,786,980	70,730	9,619,307
Miscellaneous [g]			1,100,342		1,109,480
Total value, eliminating duplications			59,400,591		74,707,269

[a] No data available.
[b] Value included under "Miscellaneous."
[c] Figures obtained through cooperation with Bureau of the Census.
[d] Value not included in total value for State.
[e] Figures by States not available for 1923.
[f] Exclusive of sandstone in 1922 and of basalt in 1923, value for which is included under "Miscellaneous."
[g] Includes minerals indicated by "[b]" and "[f]" above.

Mineral production of Nebraska in 1922 and 1923

Product		1922		1923	
		Quantity	Value	Quantity	Value
Cement	barrels	[a]	[a]	[a]	[a]
Clay products			[b c] $857,185		[b c] $939,138
Clay, raw	short tons	248	[d] 890	255	[d] 965
Mineral paints, zinc and lead pigments	short tons			[a d]	[a d]
Mineral waters	gallons sold			[a]	[a]
Potash (K_2O)	short tons	[a]	[a]	250	16,250
Pumice	do	[a]	[a]	[a]	[a]
Sand and gravel	do	1,513,257	805,215	1,930,104	921,433
Stone	do	182,960	231,195	243,920	328,918
Miscellaneous [e]			1,102,992		1,099,348
Total value, eliminating duplications			2,996,587		3,302,397

[a] Value included under "Miscellaneous."
[b] Figures obtained through cooperation with Bureau of the Census.
[c] Exclusive of pottery, value for which is included under "Miscellaneous."
[d] Value not included in total value for State.
[e] Includes minerals indicated by "[a]" and "[c]" above.

Mineral production of Nevada in 1922 and 1923

Product		1922		1923	
		Quantity	Value	Quantity	Value
Arsenious oxide	short tons	[a]	[a]	9,484	$758,747
Borates	do	[b]	[b]	[b]	[b]
Clay products			[b c]		[b c]
Clay, raw	short tons	[b d]	[b d]	1,060	[d] 10,900
Cobalt	pounds	4,018	$1,419		
Copper	do	23,133,091	3,122,967	67,204,282	9,879,029
Diatomaceous earth	short tons	[b]	[b]	400	5,500
Gems and precious stones			[b]		[c]
Gold	troy ounces	159,511	3,297,384	204,293	4,223,109
Graphite, amorphous	short tons	[b]	[b]	200	[b]
Gypsum	do	276,859	2,043,974	298,390	1,952,007
Iron ore:					
Sold to furnaces	long tons	25	[b]	9,578	[b]
Sold for paint	do	26	[b]		
Lead	short tons	4,695	516,405	9,078	1,270,944
Lime	do	[b]	[b]	[b]	[b]
Manganese ore	long tons	[b]	[b]		
Manganiferous ore (for fluxing)	do			28,571	[b]
Mineral waters	gallons sold	[b]	[b]	[b]	[b]
Quicksilver	flasks	[b]	[b]	[b]	[b]
Salt	short tons			[b]	[b]
Sand and gravel	do	278,356	89,991	269,324	56,938
Shale oil	gallons			132,000	[a]
Silica (quartz)	short tons			433	2,415
Silver	troy ounces	8,619,587	8,619,587	10,614,564	8,703,942
Stone	short tons	[b]	[b]	84,240	89,585
Sulphur	long tons	[b]	[b]	[b]	[b]
Zinc	short tons	1,309	149,266	7,083	963,325
Miscellaneous [f]			536,290		693,086
Total value, eliminating duplications			18,374,023		28,598,627

[a] No data available.
[b] Value included under "Miscellaneous."
[c] Figures obtained through cooperation with Bureau of the Census.
[d] Value not included in total value for State.
[e] Figures by States not available for 1923.
[f] Includes minerals indicated by "[b]" above.

Mineral production of New Hampshire in 1922 and 1923

Product		1922		1923	
		Quantity	Value	Quantity	Value
Clay products			[a] $603,322		[a b] $913,389
Diatomaceous earth	short tons	[c]	[c]	50	2,500
Feldspar (crude)	long tons	14,017	116,751	23,220	171,789
Fluorspar	short tons	690	15,353	142	3,160
Garnet, abrasive	do	[c]	[c]	[c]	[c]
Mica:					
Scrap	do	238	5,838	1,078	25,871
Sheet	pounds	475,647	63,240	835,751	107,674
Mineral waters	gallons sold	[c]	[c]	156,607	12,642
Peat	short tons	50	50		
Sand and gravel	do	442,509	357,900	505,063	423,854
Scythestones	do	[c]	[c]	[c]	[c]
Silica (quartz)	do			[c]	[c]
Stone	do	128,650	1,071,556	122,460	1,763,221
Miscellaneous [d]			49,109		148,515
Total value, eliminating duplications			2,283,119		3,572,615

[a] Figures obtained through cooperation with Bureau of the Census.
[b] Exclusive of pottery, value for which is included under "Miscellaneous."
[c] Value included under "Miscellaneous."
[d] Includes minerals indicated by "[b]" and "[c]" above.

Mineral production of New Jersey in 1922 and 1923

Product	1922		1923	
	Quantity	Value	Quantity	Value
Briquets, fuel short tons	(a b)	(a b)	(a b)	(a b)
Cement barrels	(a)	(a)	(a)	(a)
Clay products		c $38, 124, 888		c $44, 921, 714
Clay, raw short tons	313, 360	b 1, 206, 947	376, 854	b 1, 650, 900
Coke do	790, 811	(a b)	897, 569	(a b)
Ferroalloys long tons	(a b)	(a b)	(a b)	(a b)
Iron ore do	90, 374	400, 356	349, 435	1, 403, 723
Iron, pig do	88, 908	(a b)	206, 196	(a b)
Lime short tons	2, 392	20, 845	(a)	(a)
Manganiferous residuum d long tons	81, 333	(a)	132, 801	(a)
Marl, greensand short tons	7, 885	56, 800	10, 656	131, 123
Mineral paints, zinc and lead pigments do	(a b)	(a b)	(a b)	(a b)
Mineral waters gallons sold	290, 808	30, 800	507, 680	50, 261
Peat short tons	39, 095	193, 940	18, 380	107, 885
Sand and gravel do	4, 854, 433	3, 425, 013	6, 101, 204	4, 381, 855
Sand and sandstone (finely ground) do	(a)	(a)	(a)	(a)
Slate		(a)		(a)
Stone short tons	1, 903, 840	2, 850, 557	2, 039, 740	3, 032, 918
Talc do	(a)	(a)	(a)	(a)
Zinc do	73, 657	(a)	75, 227	(a)
Miscellaneous e		27, 322, 876		32, 722, 018
Total value, eliminating duplications		62, 396, 379		72, 602, 066

a Value included under "Miscellaneous."
b Value not included in total value for State.
c Figures obtained through cooperation with Bureau of the Census.
d Ore mined in New Jersey; smelted in Pennsylvania.
e Includes minerals indicated by "a" above.

Mineral production of New Mexico in 1922 and 1923

Product	1922		1923	
	Quantity	Value	Quantity	Value
Clay products		(a b)		a $133, 118
Clay, raw short tons	1, 681	c $6, 542	3, 135	c 11, 939
Coal do	3, 147, 173	10, 977, 000	2, 915, 173	10, 668, 000
Coke do	87, 631	c 788, 679	(b c)	(b c)
Copper pounds	31, 937, 207	4, 311, 523	61, 356, 802	9, 019, 450
Fluorspar short tons	2, 180	30, 992	4, 328	50, 861
Gems and precious stones		(b)		(d)
Gold troy ounces	19, 964	412, 693	26, 689	551, 713
Gypsum short tons	(b)	(b)	(b)	(b)
Iron ore long tons	118, 038	(b)	205, 218	(b)
Lead short tons	1, 506	165, 672	1, 916	268, 270
Lime do	3, 587	38, 520	1, 859	19, 362
Lithium minerals do	(b)	(b)	(b)	(b)
Manganese ore long tons			179	3, 693
Manganiferous ore:				
For fluxing do	8, 764	(b)		
For other purposes do	28, 623	(b)	6, 759	17, 398
Mica:				
Scrap short tons	(b)	(b)	898	16, 417
Sheet pounds			30, 300	8, 489
Mineral paints, zinc and lead pigments short tons	(b c)	(b c)		
Mineral waters gallons sold	(b)	(b)	2, 125	643
Molybdenum pounds			22, 667	(b)
Natural gas M cubic feet			(b)	(b)
Petroleum barrels	(b)	(b)	(b)	(b)
Salt short tons	718	5, 747	525	5, 250
Sand and gravel do	244, 315	146, 670	464, 410	239, 470
Silver troy ounces	752, 240	752, 240	747, 127	612, 644
Stone short tons	366, 300	224, 525	e 396, 980	e 241, 786
Zinc do	2, 248	256, 318	8, 248	1, 121, 728
Miscellaneous f		952, 193		1, 946, 315
Total value, eliminating duplications		18, 038, 022		23, 791, 047

a Figures obtained through cooperation with Bureau of the Census.
b Value included under "Miscellaneous."
c Value not included in total value for State.
d Figures by States not available for 1923.
e Exclusive of limestone, value for which is included under "Miscellaneous."
f Includes minerals indicated by "b" and "e" above.

Mineral production of New York in 1922 and 1923

Product	1922		1923	
	Quantity	Value	Quantity	Value
Aluminum pounds	(a b)	(a b)	(a b)	(a b)
Cement barrels	c 6,194,663	c $10,694,426	c 6,853,062	c $12,834,471
Clay products		d 20,548,809		d 25,226,187
Clay, raw short tons	5,976	b 20,463	8,247	b 43,701
Coke do	1,494,992	b 11,865,785	1,783,948	b 12,808,335
Diatomaceous earth do	(a)	(a)	208	13,378
Emery do	(a)	(a)	461	3,427
Feldspar (crude) long tons	(a)	(a)	15,161	127,477
Ferroalloys do	88,585	b 7,373,187	87,872	b 9,568,252
Garnet, abrasive short tons	(a)	(a)	7,662	583,190
Graphite, artificial pounds	13,031,926	(a b)	26,761,015	(a b)
Gypsum short tons	1,055,302	8,807,366	1,361,116	10,344,745
Iron ore:				
Sold to furnaces long tons	191,195	1,049,050	722,096	3,242,229
Sold for paint do	14,769	(a)	12,849	77,775
Iron, pig do	1,708,605	b 37,783,073	2,426,522	b 57,543,779
Lime short tons	96,320	957,079	100,862	1,037,737
Magnesium pounds	(e)	(e)	(a b)	(a b)
Marl, calcareous short tons	1,300	8,125	1,000	7,000
Mica, sheet pounds			(a)	(a)
Millstones		17,025		14,344
Mineral waters gallons sold	6,965,638	800,831	6,716,154	803,433
Natural gas M cubic feet	6,947,000	3,379,000	6,497,000	3,739,000
Natural-gas gasoline gallons	506,200	61,415	408,000	44,000
Peat short tons	840	4,050	862	7,545
Petroleum barrels	1,000,000	3,144,000	1,250,000	4,140,000
Pyrites long tons	5,900	(a)	11,000	(a)
Salt short tons	1,960,867	7,066,409	2,065,842	7,431,155
Sand and gravel do	8,303,392	5,085,312	10,730,225	7,291,076
Sand-lime brick thousands	(f)	(f)	d 15,646	d 204,433
Silica (quartz) short tons	(a)	(a)	1,540	7,700
Slate		642,972		927,398
Stone short tons	g 6,463,770	g 8,744,124	7,043,880	9,610,324
Talc do	71,470	1,116,914	71,304	1,079,322
Zinc do	4,816	549,024	8,463	1,150,968
Miscellaneous h		9,633,519		19,304,748
Total value, eliminating duplications		73,527,880		89,975,134

a Value included under "Miscellaneous."
b Value not included in total value for State.
c Exclusive of natural cement, value for which is included under "Miscellaneous."
d Figures obtained through cooperation with Bureau of the Census.
e No data available.
f No canvass for 1922.
g Exclusive of unclassified stone, value for which is included under "Miscellaneous."
h Includes minerals indicated by "a," "e," and "g" above.

Mineral production of North Carolina in 1922 and 1923

Product	1922		1923	
	Quantity	Value	Quantity	Value
Aluminum pounds	(a b)	(a b)	(a b)	(a b)
Barytes short tons	(a)	(a)	1,179	$7,076
Clay products		c $3,012,310		c d 3,656,452
Clay, raw short tons	14,656	b 214,622	23,793	b 369,518
Coal do	78,570	388,000	36,019	132,000
Copper pounds			61,983	9,112
Feldspar (crude) long tons	56,043	333,745	57,622	360,636
Garnet, abrasive short tons			(a)	(a)
Gems and precious stones		(a)		(e)
Gold troy ounces	94	1,939	53	1,102
Iron ore long tons	19,279	49,415	59,684	161,603
Lime short tons	(a)	(a)	(a)	(a)
Marl, calcareous do	(a)	(a)	2,000	6,000
Mica:				
Scrap do	4,205	65,923	5,005	65,764
Sheet pounds	544,495	119,767	1,130,283	188,317
Millstones		(a)		(a)
Mineral waters gallons sold	65,020	9,941	74,745	7,840
Peat short tons	400	8,000		
Sand and gravel do	764,940	634,924	2,052,917	1,414,539
Silica (quartz) do			(a)	(a)
Silver troy ounces	9	9	78	64
Stone short tons	f 948,810	f 2,483,851	f 1,397,460	f 3,579,351
Talc do	2,194	23,049	6,491	89,290
Miscellaneous g		3,556,630		6,511,903
Total value, eliminating duplications		7,268,381		10,020,559

a Value included under "Miscellaneous."
b Value not included in total value for State.
c Figures obtained through cooperation with Bureau of the Census.
d Exclusive of pottery, value for which is included under "Miscellaneous."
e Figures by States not available for 1923.
f Exclusive of marble in 1922 and of marble and unclassified stone in 1923, value for which is included under "Miscellaneous."
g Includes minerals indicated by "a," "d," and "f" above.

Mineral production of North Dakota in 1922 and 1923

Product	1922		1923	
	Quantity	Value	Quantity	Value
Clay products		a $173,715		a $181,933
Clay, raw short tons	45	b 474	29	b 384
Coal do	1,327,564	3,513,000	1,385,400	3,275,000
Mineral waters gallons sold	(c)	(c)	(c)	(c)
Natural gas M cubic feet	600	300	(c)	(c)
Sand and gravel short tons	(c)	(c)	(c)	(c)
Miscellaneous d		6,080		16,085
Total value, eliminating duplications		3,693,095		3,473,018

a Figures obtained through cooperation with Bureau of the Census.
b Value not included in total value for State.
c Value included under "Miscellaneous."
d Includes minerals indicated by "c" above.

Mineral production of Ohio in 1922 and 1923

Product	1922		1923	
	Quantity	Value	Quantity	Value
Bromine ---- pounds	(a)	(a)	(a)	(a)
Calcium chloride ---- short tons	(a)	(a)	(a)	(a)
Cement ---- barrels	[b] 2,913,034	[b] $5,243,687	[b] 4,003,321	[b] $7,615,741
Clay products		[c] 71,347,314		[c] 99,078,987
Clay, raw ---- short tons	235,684	[d] 448,677	312,757	[d] 711,957
Coal ---- do	26,953,791	87,056,000	40,546,443	98,610,000
Coke ---- do	5,011,138	[d] 33,100,323	[e] 6,323,810	[e] 40,712,282
Ferroalloys ---- long tons	55,383	[d] 1,906,815	83,702	[d] 2,927,401
Grindstones and pulpstones ---- short tons	22,616	787,591	37,879	1,261,668
Gypsum ---- do	435,485	3,976,100	526,861	4,981,542
Iron, pig ---- long tons	6,756,648	[d] 149,805,909	8,964,805	[d] 222,009,553
Lime ---- short tons	752,916	6,495,066	867,982	8,740,688
Marl, calcareous ---- do	(a)	(a)	(a)	(a)
Mineral paints, zinc and lead pigments ---- do	(a d)	(a d)	(a d)	(a d)
Mineral waters ---- gallons sold	2,298,132	162,814	2,693,541	182,604
Natural gas ---- M cubic feet	51,481,000	24,181,000	53,812,000	25,675,000
Natural-gas gasoline ---- gallons	8,600,296	1,300,929	10,035,000	1,446,000
Oilstones and scythestones ---- short tons	(a)	(a)	211	34,092
Petroleum ---- barrels	6,781,000	17,369,000	7,085,000	17,050,000
Pyrites ---- long tons			138	505
Salt ---- short tons	1,105,757	3,749,564	1,102,387	3,695,248
Sand and gravel ---- do	6,999,962	5,503,374	10,126,977	7,863,375
Sand-lime brick ---- thousands	(f)	(f)	(a c)	(a c)
Stone ---- short tons	9,137,480	9,564,640	11,493,340	11,464,569
Miscellaneous [g]		1,471,724		2,973,589
Total value, eliminating duplications		236,808,638		287,868,728

[a] Value included under "Miscellaneous."
[b] Exclusive of natural cement, value for which is included under "Miscellaneous."
[c] Figures obtained through cooperation with Bureau of the Census.
[d] Value not included in total value for State.
[e] Exclusive of 149,796 tons of beehive coke, value for which is included under "Miscellaneous," but not in total value for State.
[f] No canvass for 1922.
[g] Includes minerals indicated by "a," "b," and "e" above.

Mineral production of Oklahoma in 1922 and 1923

Product	1922		1923	
	Quantity	Value	Quantity	Value
Asphalt ---- short tons	48,597	$184,035	44,149	$285,122
Cement ---- barrels	(a)	(a)	(a)	(a)
Clay products		[b] 1,935,570		[b] 1,870,436
Coal ---- short tons	2,802,511	11,527,000	2,885,038	10,874,000
Coke ---- do			(a c)	(a c)
Gypsum ---- do	242,932	1,651,837	290,121	2,248,895
Lead ---- do	62,856	6,914,160	66,904	9,366,560
Lime ---- do	(a)	(a)	(a)	(a)
Manganese ore ---- long tons			(a)	(a)
Mineral paints, zinc and lead pigments ---- short tons	(a c)	(a c)	(a c)	(a c)
Mineral waters ---- gallons sold	1,434,885	46,047	996,564	34,562
Natural gas ---- M cubic feet	140,631,000	33,475,800	203,082,000	31,126,000
Natural-gas gasoline ---- gallons	189,403,670	24,914,048	270,249,000	23,012,000
Petroleum ---- barrels	149,571,000	258,160,000	160,929,000	279,700,000
Sand and gravel ---- short tons	1,357,272	903,043	1,404,185	974,461
Stone ---- do	1,156,950	1,327,370	[d] 1,265,900	[d] 1,427,920
Tripoli ---- do	(a)	(a)	(a)	(a)
Zinc ---- do	209,682	23,903,748	242,421	32,969,256
Miscellaneous [e]		4,283,343		5,025,554
Total value, eliminating duplications		369,069,612		398,857,652

[a] Value included under "Miscellaneous."
[b] Figures obtained through cooperation with Bureau of the Census.
[c] Value not included in total value for State.
[d] Exclusive of unclassified stone, value for which is included under "Miscellaneous."
[e] Includes minerals indicated by "a" and "d" above.

Mineral production of Oregon in 1922 and 1923

Product	1922		1923	
	Quantity	Value	Quantity	Value
Briquets, fuel ..... short tons	(a b)	(a b)	(a b)	(a b)
Cement ..... barrels	(a)	(a)	(a)	(a)
Chromite ..... long tons	79	$632	78	$564
Clay products	.....	c d 569, 289	.....	c d 612, 785
Clay, raw ..... short tons	3, 288	b 9, 527	1, 101	b 2, 833
Coal ..... do	(a)	(a)	(a)	(a)
Copper ..... pounds	1, 046, 525	141, 281	1, 283, 476	188, 671
Diatomaceous earth ..... short tons	(a)	(a)	(a)	(a)
Gems and precious stones	.....	(a)	.....	(e)
Gold ..... troy ounces	25, 715	531, 568	24, 091	498, 008
Gypsum ..... short tons	(a)	(a)	(a)	(a)
Lead ..... do	38	4, 233	14	1, 927
Lime ..... do	(a)	(a)	(a)	(a)
Mineral waters ..... gallons sold	2, 621	598	3, 058	588
Platinum and allied metals ..... troy ounces	78	9, 536	77	11, 952
Quicksilver ..... flasks	2	116	(a)	(a)
Sand and gravel ..... short tons	1, 524, 827	1, 178, 278	1, 702, 439	1, 320, 483
Silver ..... troy ounces	151, 812	151, 812	96, 322	78, 984
Stone ..... short tons	661, 070	897, 784	1, 103, 330	1, 342, 070
Miscellaneous f	.....	2, 831, 397	.....	2, 719, 693
Total value, eliminating duplications	.....	5, 489, 956	.....	6, 054, 487

[a] Value included under "Miscellaneous."
[b] Value not included in total value for State.
[c] Figures obtained through cooperation with Bureau of the Census.
[d] Exclusive of pottery, value for which is included under "Miscellaneous."
[e] Figures by States not available for 1923.
[f] Includes minerals indicated by "a" and "d" above.

Mineral production of Pennsylvania in 1922 and 1923

Product	1922		1923	
	Quantity	Value	Quantity	Value
Briquets, fuel ..... short tons	114, 158	a $676, 970	194, 973	a $1, 160, 254
Cement ..... barrels	b 34, 023, 695	b 55, 528, 002	b 38, 610, 852	b 69, 792, 343
Clay products	.....	c 41, 683, 044	.....	c 58, 529, 481
Clay, raw ..... short tons	381, 259	a 1, 306, 253	517, 392	a 1, 626, 882
Coal:				
Anthracite ..... do	54, 683, 022	273, 700, 125	93, 339, 009	506, 786, 768
Bituminous ..... do	113, 148, 308	351, 777, 000	171, 879, 913	472, 217, 000
Coke ..... do	13, 991, 892	a 74, 794, 560	25, 624, 286	a 138, 444, 191
Copper ..... pounds	1, 229, 926	166, 040	1, 708, 480	250, 411
Feldspar (crude) ..... long tons	(d)	(d)	2, 069	6, 355
Ferroalloys ..... do	206, 966	a 14, 148, 302	317, 470	a 28, 515, 265
Fuller's earth ..... short tons	(d)	(d)	.....	.....
Gems and precious stones	.....	(d)	.....	(e)
Gold ..... troy ounces	126	2, 600	157	3, 246
Iron ore:				
Sold to furnaces ..... long tons	782, 916	1, 022, 756	988, 586	2, 264, 485
Sold for paint ..... do	3, 256	(d)	3, 516	(d)
Iron, pig ..... do	9, 732, 024	a 221, 581, 288	13, 898, 624	a 347, 679, 274
Lime ..... short tons	719, 536	5, 581, 794	772, 839	6, 372, 732
Marl, calcareous ..... do	(d)	(d)	.....	.....
Mineral paints, zinc and lead pigments .. do	(a d)	(a d)	(a d)	(a d)
Mineral waters ..... gallons sold	824, 988	81, 435	807, 522	84, 945
Natural gas ..... M cubic feet	101, 276, 000	39, 835, 000	112, 562, 000	45, 873, 000
Natural-gas gasoline ..... gallons	18, 518, 131	3, 144, 545	19, 132, 000	2, 560, 000
Peat ..... short tons	.....	.....	(d)	(d)
Petroleum ..... barrels	7, 425, 000	23, 834, 000	7, 609, 000	25, 320, 000
Potash (K_2O) ..... short tons	(d)	(d)	(d)	(d)
Sand and gravel ..... do	7, 352, 988	7, 413, 686	9, 221, 292	9, 944, 019
Sand and sandstone (finely ground) ..... do	(d)	(d)	(f)	(f)
Sand-lime brick ..... thousands	(g)	(g)	(e d)	(e d)
Silica (quartz) ..... short tons	(d)	(d)	.....	.....

[a] Value not included in total value for State.
[b] Exclusive of natural cement, value for which is included under "Miscellaneous."
[c] Figures obtained through cooperation with Bureau of the Census.
[d] Value included under "Miscellaneous."
[e] Figures by States not available for 1923.
[f] Included under "Sand and gravel."
[g] No canvass for 1922.

Mineral production of Pennsylvania in 1922 and 1923—Continued

Product		1922		1923	
		Quantity	Value	Quantity	Value
Silver	troy ounces	2,215	$2,215	3,005	$2,464
Slate			4,324,294		5,587,670
Stone	short tons	12,731,940	14,591,194	[h] 15,679,170	[h] 18,997,295
Sulphuric acid [i]	do	[a]	[a]	[a c d]	[a c d]
Talc	do	[d]	[d]	[d]	[d]
Tripoli (rottenstone)	do	[d]	[d]	[d]	[d]
Miscellaneous [i]			14,772,068		14,544,467
Total value, eliminating duplications			823,148,222		1,225,036,404

[a] Value not included in total value for State.
[c] Figures obtained through cooperation with Bureau of the Census.
[d] Value included under "Miscellaneous."
[g] No canvass for 1922.
[h] Exclusive of serpentine, value for which is included under "Miscellaneous."
[i] From zinc smelting.
[j] Includes minerals indicated by "[b]", "[d]", and "[h]" above.

Mineral production of Rhode Island in 1922 and 1923

Product		1922		1923	
		Quantity	Value	Quantity	Value
Clay products			[a b]		[a b]
Coke	short tons	[a c]	[a c]	[a c]	[a c]
Graphite, amorphous	do	[a]	[a]	3,000	[a]
Lime	do	[a]	[a]	[a]	[a]
Mineral waters	gallons sold	279,109	$25,704	277,945	$26,211
Sand and gravel	short tons	12,441	17,661	69,714	36,373
Stone	do	[d] 73,400	[d] 357,635	[d] 161,080	[d] 649,359
Miscellaneous [e]			1,827,158		2,315,116
Total value, eliminating duplications			770,966		1,022,528

[a] Value included under "Miscellaneous."
[b] Figures obtained through cooperation with Bureau of the Census.
[c] Value not included in total value for State.
[d] Exclusive of limestone, value for which is included under "Miscellaneous."
[e] Includes minerals indicated by "[a]" and "[d]" above.

Mineral production of South Carolina in 1922 and 1923

Product		1922		1923	
		Quantity	Value	Quantity	Value
Barytes	short tons	[a]	[a]	[a]	[a]
Clay products			[b c] $884,513		[b c] $1,448,790
Clay, raw	short tons	53,577	[d] 416,725	55,048	[d] 454,412
Gold	troy ounces	2	32	15	313
Marl, calcareous	short tons			[a]	[a]
Mica:					
Scrap	do	[a]	[a]	[a]	[a]
Sheet	pounds			[a]	[a]
Mineral waters	gallons sold	96,900	21,622	121,576	25,078
Phosphate rock	long tons	1,500	8,250		
Sand and gravel	short tons	422,750	297,898	581,048	336,109
Silver	troy ounces			1	1
Stone	short tons	638,400	1,175,049	847,870	1,657,926
Miscellaneous [e]			26,982		81,842
Total value, eliminating duplications			2,414,346		3,550,059

[a] Value included under "Miscellaneous."
[b] Figures obtained through cooperation with Bureau of the Census.
[c] Exclusive of pottery, value for which is included under "Miscellaneous."
[d] Value not included in total value for State.
[e] Includes minerals indicated by "[a]" and "[c]" above.

Mineral production of South Dakota in 1922 and 1923

Product	1922		1923	
	Quantity	Value	Quantity	Value
Clay products		[a b]		[a b]
Clay, raw, short tons	100	[c] $1,000	400	[c] $4,000
Coal, do	7,752	22,000	10,379	25,000
Columbite, pounds	600	240	1,350	540
Gems and precious stones		[b]		[d]
Gold, troy ounces	315,298	6,517,788	309,905	6,406,306
Gypsum, short tons	[b]	[b]	[b]	[b]
Lime, do	3,852	43,990	[b]	[b]
Lithium minerals, do	[b]	[b]	[b]	[b]
Mica, scrap, do	[b]	[b]	324	6,480
Mineral waters, gallons sold	796,500	32,850	780,500	29,610
Natural gas, M cubic feet	15,600	6,400	33,000	16,600
Sand and gravel, short tons	200,408	121,690	304,768	156,914
Sand-lime brick, thousands	[e]	[e]	[a b]	[a b]
Silver, troy ounces	118,760	118,760	95,844	78,592
Stone, short tons	133,920	272,152	250,730	479,288
Miscellaneous [f]		143,064		173,038
Total value, eliminating duplications		7,278,934		7,372,368

[a] Figures obtained through cooperation with Bureau of the Census.
[b] Value included under "Miscellaneous."
[c] Value not included in total value for State.
[d] Figures by States not available for 1923.
[e] No canvass for 1922.
[f] Includes minerals indicated by "[b]" above.

Mineral production of Tennessee in 1922 and 1923

Product	1922		1923	
	Quantity	Value	Quantity	Value
Aluminum, pounds	[a b]	[a b]	[a b]	[a b]
Barytes, short tons	16,642	$124,204	34,384	$259,005
Bauxite, long tons	[a]	[a]	[a]	[a]
Cement, barrels	[a]	[a]	[a]	[a]
Clay products		[c] 4,278,270		[c] 4,879,848
Clay, raw, short tons	74,114	[b] 362,281	105,341	[b] 529,551
Coal, do	4,876,774	14,096,000	6,040,268	16,515,000
Coke, do	113,896	[b] 820,878	304,511	[b] 2,069,553
Copper, pounds	14,240,571	1,922,477	18,721,932	2,752,124
Ferroalloys, long tons	[a b]	[a b]	19,390	[b] 1,424,130
Gold, troy ounces	209	4,320	320	6,615
Iron ore:				
Sold to furnaces, long tons	159,473	418,578	266,175	677,753
Sold for paint, do	700	[a]	1,100	[a]
Iron, pig, do	95,326	[b] 2,063,376	215,009	[b] 5,793,756
Lead, short tons	732	80,520	1,250	175,000
Lime, do	126,305	939,039	131,995	1,028,158
Manganese ore, long tons	113	1,636	213	5,611
Mineral waters, gallons sold	1,005,119	67,838	649,348	41,737
Natural gas, M cubic feet	3,000	800	4,100	1,000
Petroleum, barrels	9,800	17,000	8,000	14,000
Phosphate rock, long tons	339,027	2,003,342	415,711	2,255,040
Sand and gravel, short tons	1,571,492	1,193,133	1,868,337	1,253,084
Sand and sandstone (finely ground), do	[a]	[a]		
Sand-lime brick, thousands	[d]	[d]		
Silver, troy ounces	78,341	78,341	105,712	86,684
Slate		[a]		[a]
Stone, short tons	[e] 1,091,530	[e] 3,759,876	1,454,180	4,341,393
Sulphuric acid [f], do	[d]	[d]	[a b c]	[a b c]
Zinc, do	15,568	1,774,752	15,900	2,162,400
Miscellaneous [g]		7,733,704		11,778,544
Total value, eliminating duplications		35,146,266		41,553,789

[a] Value included under "Miscellaneous."
[b] Value not included in total value for State.
[c] Figures obtained through cooperation with Bureau of the Census.
[d] No canvass for 1922.
[e] Exclusive of sandstone, value for which is included under "Miscellaneous."
[f] From copper smelting.
[g] Includes minerals indicated by "[a]" and "[e]" above.

Mineral production of Texas in 1922 and 1923

Product		1922		1923	
		Quantity	Value	Quantity	Value
Asphalt	short tons	340,334	$3,414,837	394,535	$4,337,085
Cement	barrels	3,730,477	7,515,932	4,091,284	8,011,226
Clay products			[a] 4,376,401		[a] 5,572,665
Clay, raw	short tons	3,554	[b] 22,601	3,823	[b] 23,873
Coal	do	1,106,007	2,563,000	1,187,329	2,162,000
Copper	pounds	4,290	579	4,257	625
Fuller's earth	short tons	12,285	123,536	19,465	186,205
Gems and precious stones			[c]		[d]
Gold	troy ounces			39	802
Graphite, crystalline	pounds	[c]	[c]	[c]	[c]
Gypsum	short tons	221,914	2,081,479	344,104	2,237,024
Lead	do	4	441	13	1,862
Lime	do	52,552	524,985	62,822	606,976
Mineral waters	gallons sold	307,478	50,737	347,973	61,231
Natural gas	M cubic feet	47,945,000	10,623,000	74,535,000	11,320,000
Natural-gas gasoline	gallons	95,405,483	12,114,952	177,765,000	14,752,000
Petroleum	barrels	118,684,000	189,175,000	131,023,000	193,580,000
Quicksilver	flasks	[c]	[c]	[c]	[c]
Salt	short tons	[c]	[c]	[c]	[c]
Sand and gravel	do	2,939,105	1,730,046	5,059,601	2,570,994
Sand-lime brick	thousands	[e]	[e]	[a c]	[a c]
Silver	troy ounces	644,980	644,980	811,824	665,696
Stone	short tons	1,335,660	1,314,203	2,200,690	2,102,281
Sulphur	long tons	[c]	[c]	[c]	[c]
Miscellaneous [f]			13,350,065		16,063,793
Total value, eliminating duplications			249,604,173		264,232,465

[a] Figures obtained through cooperation with Bureau of the Census.
[b] Value not included in total value for State.
[c] Value included under "Miscellaneous."
[d] Figures by States not available for 1923.
[e] No canvass for 1922.
[f] Includes minerals indicated by "[c]" above.

Mineral production of Utah in 1922 and 1923

Product		1922		1923	
		Quantity	Value	Quantity	Value
Arsenious oxide	short tons	[a]	[a]	5,027	$402,137
Asphalt	do	29,704	$623,207	34,635	695,622
Cement	barrels	[b]	[b]	[b]	[b]
Clay products			[c d] 860,433		[c] 936,701
Clay, raw	short tons	4,567	[e] 20,754	4,250	[e] 15,300
Coal	do	4,992,008	15,687,500	4,720,217	13,657,000
Coke	do	172,453	[e] 1,406,109	232,941	[e] 1,977,669
Copper	pounds	97,193,850	13,121,170	222,393,572	32,691,855
Diatomaceous earth	short tons	[b]	[b]		
Fluorspar	do	[b]	[b]	188	[b]
Gems and precious stones			[b]		[f]
Gold	troy ounces	111,110	2,296,855	148,825	3,076,483
Gypsum	short tons	48,338	304,562	44,531	286,957
Iron ore	long tons	15,018	63,806	57,752	205,936
Lead	short tons	67,666	7,443,268	101,724	14,241,346
Lime	do	11,082	147,087	12,228	152,136
Marl, calcareous	do			[b]	[b]
Mineral paints, zinc and lead pigments	do	[b e]	[b e]	[b e]	[b e]
Potash (K_2O)	do	536	25,711		
Pumice	do			[b]	[b]
Salt	do	81,909	387,093	81,449	468,765
Sand and gravel	do	412,544	152,469	1,212,077	290,807
Silica (quartz)	do			150	450
Silver	troy ounces	17,271,100	17,271,100	19,137,470	15,692,725
Sodium sulphate from natural sources	short tons	[b]	[b]		
Stone	do	411,590	380,246	784,750	608,991
Sulphur	long tons	[b]	[b]	[b]	[b]
Uranium and vanadium ores	short tons	338	92,141	[b]	[b]
Zinc	do	2,560	291,806	5,665	770,502
Miscellaneous [g]			1,556,492		2,086,310
Total value, eliminating duplications			60,697,116		86,221,000

[a] No data available.
[b] Value included under "Miscellaneous."
[c] Figures obtained through cooperation with Bureau of the Census.
[d] Exclusive of pottery, value for which is included under "Miscellaneous."
[e] Value not included in total value for State.
[f] Figures by States not available for 1923.
[g] Includes minerals indicated by "[b]" and "[d]" above.

Mineral production of Vermont in 1922 and 1923

Product	1922		1923	
	Quantity	Value	Quantity	Value
Asbestos short tons	[a]	[a]		
Clay products		[a b]		[a b]
Clay, raw short tons	[a c]	[a c]	417	[c] $3,682
Lime do	44,745	$565,498	58,681	702,588
Mineral waters gallons sold	[a]	[a]	[a]	[a]
Sand and gravel short tons	64,089	19,295	55,551	18,793
Scythestones do	[a]	[a]	[a]	[a]
Slate		2,907,858		3,857,287
Stone short tons	190,410	5,331,970	342,520	8,661,906
Talc do	75,485	654,715	67,100	533,510
Miscellaneous [d]		109,330		136,365
Total value, eliminating duplications		9,576,636		13,910,449

[a] Value included under "Miscellaneous."
[b] Figures obtained through cooperation with Bureau of the Census.
[c] Value not included in total value for State.
[d] Includes minerals indicated by "[a]" above.

Mineral production of Virginia in 1922 and 1923

Product	1922		1923	
	Quantity	Value	Quantity	Value
Barytes short tons			[a]	[a]
Briquets, fuel do	[a b]	[a b]	[a b]	[a b]
Cement barrels	[a]	[a]	[a]	[a]
Clay products		[c d] $2,845,510		[c] $4,318,752
Clay, raw short tons	13,810	[b] 113,828	14,303	[b] 128,071
Coal do	10,491,174	27,083,000	11,761,643	32,468,000
Coke do	378,656	[b] 2,291,336	774,887	[b] 5,086,612
Diatomaceous earth do	[a]	[a]		
Emery do	[a]	[a]	[a]	[a]
Feldspar (crude) long tons	25	163	[a]	[a]
Ferroalloys do	[a b]	[a b]	[a b]	[a b]
Gold troy ounces	34	706		
Gypsum short tons	[a]	[a]	[a]	[a]
Iron ore long tons	30,359	120,685	200,966	664,240
Iron, pig do	31,022	[b] 793,903	238,742	[b] 6,389,149
Lime short tons	152,436	1,251,683	182,604	1,490,306
Manganese ore long tons	800	[a]	987	42,020
Manganiferous ore do			661	3,685
Marl, calcareous short tons	28,971	57,887	36,937	87,714
Mica:				
Scrap do	296	9,718	[a]	[a]
Sheet pounds	43,449	6,577	[a]	[a]
Millstones		[a]		[a]
Mineral black short tons	[a]	[a]		
Mineral paints, zinc and lead pigments do			[a b]	[a b]
Mineral waters gallons sold	840,113	111,879	836,709	104,680
Pyrites long tons	[a]	[a]	[a]	[a]
Salt short tons	[a]	[a]	[a]	[a]
Sand and gravel do	1,570,775	1,333,441	2,193,861	1,665,439
Silver troy ounces	6	6		
Slate		[e] 312,652		[e] 321,010
Stone short tons	1,626,740	1,801,778	2,216,140	2,482,937
Talc and soapstone do	25,351	736,132	26,095	960,628
Titanium minerals:				
Ilmenite do	600	[a]	466	[a]
Rutile do	310	[a]	270	[a]
Miscellaneous [f]		3,249,554		3,943,361
Total value, eliminating duplications		38,551,479		48,052,018

[a] Value included under "Miscellaneous."
[b] Value not included in total value for State.
[c] Figures obtained through cooperation with Bureau of the Census.
[d] Exclusive of pottery, value for which is included under "Miscellaneous."
[e] Exclusive of granules, value for which is included under "Miscellaneous."
[f] Includes minerals indicated by "[a]," "[d]," and "[e]" above.

Mineral production of Washington in 1922 and 1923

Product	1922		1923	
	Quantity	Value	Quantity	Value
Briquets, fuel short tons	(a b)	(a b)	(a b)	(a b)
Cement barrels	1,951,414	$4,684,624	2,111,479	$4,988,022
Clay products		c 1,982,759		c 2,296,242
Clay, raw short tons	6,136	b 14,745	10,491	b 29,040
Coal do	2,581,165	10,279,000	2,926,392	10,894,000
Coke do	31,674	b 285,881	69,068	b 584,512
Copper pounds	317,203	42,822	871,999	128,184
Diatomaceous earth short tons	(a)	(a)	645	3,030
Gold troy ounces	9,044	186,965	16,547	342,067
Lead short tons	691	75,966	1,453	203,454
Lime do	25,447	355,412	25,895	359,510
Magnesite do	(a)	(a)	73,900	165,100
Magnesium sulphate (natural) pounds	(d)	(d)	(a)	(a)
Mineral waters gallons sold	(a)	(a)	124,273	11,883
Platinum troy ounces	3	306		
Pulpstones short tons	(d)	(d)	(a)	(a)
Sand and gravel do	1,802,121	844,252	3,789,109	1,363,006
Silica (quartz) do			460	3,120
Silver troy ounces	205,046	205,046	227,187	186,293
Stone short tons	• 647,160	• 887,175	678,880	953,831
Zinc do	614	70,009	1,512	205,668
Miscellaneous f		519,165		740,354
Total value, eliminating duplications		19,725,303		22,169,191

a Value included under "Miscellaneous."
b Value not included in total value for State.
c Figures obtained through cooperation with Bureau of the Census.
d No data available.
e Exclusive of sandstone, value for which is included under "Miscellaneous."
f Includes minerals indicated by "a" and "•" above.

Mineral production of West Virginia in 1922 and 1923

Product	1922		1923	
	Quantity	Value	Quantity	Value
Bromine pounds	117,931	$12,147	140,060	$20,863
Calcium chloride short tons	6,121	63,442	10,607	62,376
Cement barrels	(a)	(a)	(a)	(a)
Clay products		b 12,979,381		b 17,574,096
Clay, raw short tons	58,692	c 94,371	76,315	c 158,294
Coal do	80,488,192	236,162,000	107,899,941	285,481,000
Coke do	919,744	c 6,112,387	1,762,775	c 11,103,716
Ferroalloys long tons	(a c)	(a c)	(a c)	(a c)
Grindstones and pulpstones short tons	2,896	203,016	7,017	351,855
Iron, pig long tons	309,944	c 7,537,184	506,543	c 12,499,112
Lime short tons	219,146	1,643,055	241,601	2,029,061
Marl, calcareous do	(a)	(a)	(a)	(a)
Mineral waters gallons sold	380,726	32,137	478,520	70,447
Natural gas M cubic feet	195,288,000	69,464,000	203,867,000	69,981,000
Natural-gas gasoline gallons	56,795,713	9,770,884	63,381,000	8,890,000
Petroleum barrels	7,021,000	22,891,000	6,358,000	20,822,000
Salt short tons	25,188	283,257	31,589	284,196
Sand and gravel do	1,553,929	2,063,781	2,437,600	3,200,648
Sand and sandstone (finely ground) do	(a)	(a)	(d)	(d)
Stone do	2,163,470	2,134,944	2,550,710	2,660,415
Sulphuric acid • do	(•)	(•)	(a b c)	(a b c)
Miscellaneous f		1,732,912		2,304,249
Total value, eliminating duplications		358,772,116		412,866,535

a Value included under "Miscellaneous."
b Figures obtained through cooperation with Bureau of the Census.
c Value not included in total value for State.
d Included under "Sand and gravel."
• From zinc smelting. No canvass for 1922.
f Includes minerals indicated by "a" above.

Mineral production of Wisconsin in 1922 and 1923

Product	1922		1923	
	Quantity	Value	Quantity	Value
Barytes short tons			[a]	[a]
Briquets, fuel do	[a b]	[a b]	[a b]	[a b]
Clay products		[c d] $926,536		[c d] $1,058,138
Clay, raw short tons	230	[b] 748	122	[b] 397
Coke do	[a b]	[a b]	[a b]	[a b]
Iron ore:				
Sold to furnaces long tons	794,673	2,455,660	831,412	2,421,194
Sold for paint do	4,622	9,611	2,990	4,680
Iron, pig do	209,289	[b] 4,970,227	280,457	[b] 7,264,981
Lead short tons	691	76,010	734	102,760
Lime do	189,558	1,589,931	227,549	2,055,646
Manganiferous ore long tons	2,860	[a]	353,046	[a]
Marl, calcareous short tons	[a]	[a]	[a]	[a]
Mineral paints, zinc and lead pigments short tons	9,217	[b] 1,121,235	[a b]	[a b]
Mineral waters gallons sold	6,126,143	2,120,669	6,977,448	2,612,452
Pyrites long tons	600	1,651	190	903
Sand and gravel short tons	3,433,996	1,957,624	5,021,608	2,793,999
Sand-lime brick thousands	[e]	[e]	[a c]	[a c]
Silica (quartz) short tons	[a]	[a]	[a]	[a]
Stone do	[f] 1,800,230	[f] 3,310,387	2,488,180	4,590,528
Zinc do	10,952	1,248,528	13,211	1,796,696
Miscellaneous [g]		7,250,442		12,932,430
Total value, eliminating duplications		13,822,883		19,089,600

[a] Value included under "Miscellaneous."
[b] Value not included in total value for State.
[c] Figures obtained through cooperation with Bureau of the Census.
[d] Exclusive of pottery, value for which is included under "Miscellaneous."
[e] No canvass for 1922.
[f] Exclusive of unclassified stone, value for which is included under "Miscellaneous."
[g] Includes minerals indicated by "a," "d," and "f" above

Mineral production of Wyoming in 1922 and 1923

Product	1922		1923	
	Quantity	Value	Quantity	Value
Clay products		[a b]		[a] $136,493
Clay, raw short tons	466	[c] $7,313	614	[c] 10,448
Coal do	5,971,724	18,162,000	7,575,031	20,916,000
Copper pounds	4,296	580	111,280	16,358
Gold troy ounces	58	1,207	14	296
Gypsum short tons	47,222	269,574	33,644	176,791
Iron ore long tons	332,800	[b]	378,747	[b]
Lime short tons	[b]	[b]	[b]	[b]
Mica, scrap do			100	2,000
Mineral waters gallons sold	[b]	[b]	[b]	[b]
Natural gas M cubic feet	23,427,000	3,031,000	35,523,000	4,222,000
Natural-gas gasoline gallons	19,967,103	2,251,329	21,292,000	1,992,000
Petroleum barrels	26,715,000	33,955,000	44,785,000	48,900,000
Phosphate rock long tons			250	1,000
Platinum and allied metals troy ounces			[b]	[b]
Sand and gravel short tons	328,401	94,570	1,377,271	403,911
Silver troy ounces	57	57	254	208
Sodium salts (carbonate and sulphate) from natural sources short tons	[b]	[b]	[b]	[b]
Stone do	104,390	205,798	[d] 186,150	[d] 281,595
Miscellaneous [e]		558,169		615,895
Total value, eliminating duplications		58,529,284		77,664,547

[a] Figures obtained through cooperation with Bureau of the Census.
[b] Value included under "Miscellaneous."
[c] Value not included in total value for State.
[d] Exclusive of sandstone and unclassified stone, value for which is included under "Miscellaneous."
[e] Includes minerals indicated by "b" and "d" above.

PREFATORY NOTE TO THE REPORTS ON GOLD, SILVER, COPPER, LEAD, AND ZINC

By F. J. Katz

Geologist in Charge, Division of Mineral Resources

In the mining industry, gold, silver, copper, lead, and zinc are closely related in both the genesis and the geologic occurrence of their ores, as well as in mining and in metallurgical treatment. Of their ores some contain all five metals, many contain three or four, and few contain only one. Gold and silver, for instance, almost everywhere show close genetic relations, and their ores are usually mined together. Lead and zinc constitute a similar pair. Copper ores almost invariably yield some silver and gold as well as copper, and most lead ores yield notable supplies of silver. Zinc ores in the Western States contribute also to the production of silver. All five metals may occur in commercial quantity in a single mine or, more commonly, in a single mining district. For these reasons each of these metals is treated in Mineral Resources in a general report, and all five metals are grouped together in "mine reports" descriptive of individual or geographically grouped States. These reports are printed in 15 pamphlets.

To facilitate advance publication each report is published separately at the earliest date possible. The general reports give figures of the output of the metals in the first marketable form, as obtained from the smelters, refineries, and mints, together with general reviews of the respective industries for the entire country. The figures given in the general reports represent the final official statistics of production for the country and of the States. The general report on gold and silver includes the statistics of recovered precious metals as determined jointly by the Bureau of the Mint and the United States Geological Survey. The "mine reports" give figures of the production (called "mine production") as obtained from the mines, so far as possible in terms of recoverable metal in ores and other material sold or treated during the year; they also supply information in detail relative to the mining industry in the respective States, counties, and mining districts.

These reports, which appear as separate chapters in this volume, are as follows:

Gold and silver (general report).
Copper (general report).
Lead (general report).
Zinc (general report).
Gold, silver, copper, lead, and zinc in the Eastern States (mine report).
Silver, copper, lead, and zinc in the Central States (mine report).
Gold, silver, copper, lead, and zinc in Arizona (mine report).
Gold, silver, copper, lead, and zinc in California and Oregon (mine report).
Gold, silver, copper, lead, and zinc in Colorado (mine report).
Gold, silver, copper, lead, and zinc in Idaho and Washington (mine report).
Gold, silver, copper, lead, and zinc in Montana (mine report).
Gold, silver, copper, lead, and zinc in Nevada (mine report).
Gold, silver, copper, lead, and zinc in New Mexico and Texas (mine report).
Gold, silver, copper, and lead in South Dakota and Wyoming (mine report).
Gold, silver, copper, lead, and zinc in Utah (mine report).

In stating quantity of ores, concentrates, and similar material the short ton of 2,000 pounds is used throughout. The term "ore" as used here denotes any metalliferous material treated at the mine or shipped to reduction plants and paid for by those plants, whether or not it nets a profit to the miner. The ore classification is necessarily arbitrary, because of the varying factors affecting mining and treatment of ores. Dry and siliceous ores comprise gold and silver ores proper, as well as fluxing ores that carry considerable quantities of iron and manganese oxides and very small quantities of gold and silver, and also gold and silver ores that carry copper, lead, or zinc in quantities too low to classify them as copper, lead, zinc, or mixed ores. The copper ores include the great disseminated copper deposits of the West, the copper ores of the Lake Superior region, and other ores in which copper is the most abundant base metal paid for. The lead and zinc ores are those in which lead or zinc is the only or chief base metal present, irrespective of their precious-metal content. The mixed ores are those whose commercial value depends on the recoverable or recovered contents of two or more base metals in addition to any precious metals they may contain. If one of the metals, though present in sufficient quantity, is not recovered, that metal is disregarded in naming the ore. An improvement in metallurgy may later serve to change the name of such ore. The classification based on methods of treatment is the only satisfactory commercial classification.

It is to be understood, of course, that market values are not received by producers for metals in ore and intermediate products nor always for metals in marketable form, that payment is made in accordance with contracts for treatment or sale, and therefore that average daily quotations do not necessarily agree with average prices received.

Prices of silver, copper, lead, and zinc, 1850–1923

Year	Silver [a]	Copper [b]	Lead [c]	Zinc [d]	Year	Silver [a]	Copper [b]	Lead [c]	Zinc [d]
	Per fine ounce	*Per pound*	*Per pound*	*Per pound*		*Per fine ounce*	*Per pound*	*Per pound*	*Per pound*
1850	$1.32	$0.22	$0.05		1887	$0.98	$0.138	$0.045	$0.046
1851	1.34	.166	.05		1888	.94	.168	.044	.049
1852	1.33	.22	.05		1889	.94	.135	.039	.05
1853	1.35	.22	.06	$0.055	1890	1.05	.156	.045	.055
1854	1.35	.22	.06		1891	.99	.128	.043	.05
1855	1.34	.27	.07		1892	.87	.116	.041	.046
1856	1.34	.27	.066		1893	.78	.108	.037	.04
1857	1.35	.25	.06		1894	.63	.095	.033	.035
1858	1.34	.23	.06		1895	.65	.107	.032	.036
1859	1.36	.22	.055		1896	.68	.108	.03	.039
1860	1.35	.23	.056		1897	.60	.12	.036	.041
1861	1.33	.22	.05		1898	.59	.124	.038	.046
1862	1.35	.22	.06		1899	.60	.171	.045	.058
1863	1.345	.34	.06		1900	.62	.166	.044	.044
1864	1.345	.47	.07	.139	1901	.60	.167	.043	.041
1865	1.337	.392	.066		1902	.53	.122	.041	.048
1866	1.339	.342	.07		1903	.54	.137	.042	.054
1867	1.33	.254	.065		1904	.58	.128	.043	.051
1868	1.326	.23	.065		1905	.61	.156	.047	.059
1869	1.325	.242	.06		1906	.68	.193	.057	.061
1870	1.328	.212	.06		1907	.66	.20	.053	.059
1871	1.325	.241	.06		1908	.53	.132	.042	.047
1872	1.322	.356	.064		1909	.52	.13	.043	.054
1873	1.297	.280	.06		1910	.54	.127	.044	.054
1874	1.278	.220	.06		1911	.53	.125	.045	.057
1875	1.24	.227	.058	.07	1912	.615	.165	.045	.069
1876	1.16	.21	.061	.072	1913	.604	.155	.044	.056
1877	1.20	.19	.055	.06	1914	.553	.133	.039	.051
1878	1.15	.166	.036	.049	1915	.507	.175	.047	.124
1879	1.12	.186	.041	.052	1916	.658	.246	.069	.134
1880	1.15	.214	.05	.055	1917	.824	.273	.086	.102
1881	1.13	.182	.048	.052	1918	1.00	.247	.071	.091
1882	1.14	.191	.049	.053	1919	1.12	.186	.053	.073
1883	1.11	.165	.043	.045	1920	1.09	.184	.08	.081
1884	1.11	.13	.037	.044	1921	1.00	.129	.045	.05
1885	1.07	.108	.040	.043	1922	1.00	.135	.055	.057
1886	.99	.111	.046	.044	1923	.82	.147	.07	.068

[a] Report of Director of the Mint, pp. 212–213, 1914. Equivalent value of fine ounce based on average price and average rate of exchange. For 1916, 1917, and 1919, dealers' buying price, New York. For 1918 average price as stated by the Bureau of the Mint. For 1920, 1921, and 1922, New York market price for domestic silver only. For 1923, average price under Pittman Act, from January 1 to June 2, for domestic silver; average New York price for all silver after June 2.

[b] Weed, W. H., Copper Handbook, vol. 11, pp. 1339, 1343, for years 1850–1903. By computation from data for years 1850–1860, p. 1339. Survey computations for electrolytic copper since 1904. For 1916 and later years, average price all marketable grades.

[c] New York price, Ingalls, W. R., Lead and zinc in the United States, p. 203, 1908. U. S. Geological Survey since 1904. For 1916, outside spot quotations, New York. For 1917 and later years, average price all grades.

[d] New York price, 1875–1904, Ingalls, W. R., Lead and zinc in the United States, p. 342, 1908. St. Louis price, U. S. Geological Survey, since 1904. For 1915 and later years, average price for all grades. Oral communication from C. E. Siebenthal for 1853 and 1864.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN THE EASTERN STATES[1]

By J. P. Dunlop

MINE PRODUCTION

The total value of the gold, silver, copper, lead, and zinc mined in the Eastern States in 1923 showed an increase of about 13.7 per cent from the corresponding value in 1922. Of the total value gold represented $11,919; silver, $89,215; copper, $3,011,647; lead, $175,000; and zinc, $14,765,885. The increase was caused mainly by the increased output and the higher selling price of copper, lead, and zinc.

The principal feature of mining in these States in 1923 was the extended operations of the large companies that produce copper and zinc and the lessened activity at the small gold placer and deep mines.

Mine production of gold, silver, copper, lead, and zinc in the Eastern States, 1922–23

Year	Number of mines	Ore sold or treated	Gold	Silver	Copper	Lead	Zinc	Total value
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1922	29	2,274,175	$12,821	80,935	15,476,497	1,472,000	188,082,000	$15,881,033
1923	21	2,936,637	11,919	108,799	20,487,395	2,500,000	199,180,000	18,053,666
Increase or decrease, 1923	−8	+662,462	−902	+27,864	+5,010,898	+1,028,000	+11,098,000	+2,172,633

GOLD AND SILVER

Of the mine output of gold in 1923 placers yielded $1,020, siliceous gold ores $438, and copper and magnetite ores $10,461. The deep and placer gold mines, which in former years produced nearly all the gold in the Eastern States, supplied only 12 per cent in 1923, and the character of the operations at such mines is best shown by the fact that their total output of $1,458 was derived from 11 properties. The small quantity of siliceous ore mined was treated in small mills by amalgamation, and none of the large mills or cyanide plants were operated. Most of the ore is of low grade, and the continued high cost of supplies and the scarcity of available labor prevented profitable mining. The gold obtained in refining copper bullion has been the

[1] U. S. Geol. Survey Mineral Resources, 1908, pt. 1, pp. 645–681, contains references to the geology of the several States and gives a list of the Geological Survey, State survey, and other publications relating to the geology and mines in all the Eastern States; and U. S. Geol. Survey Mineral Resources, 1914, pt. 1, pp. 139–163, contains a historical review of the production of gold in the Southern Appalachian States and a list of Survey publications on gold, silver, copper, lead, and zinc in the Eastern States.

only uninterrupted source of gold in these States in the last five years. The value of the estimated gold production of the Southern Appalachian States for the period 1799–1922 is $51,055,432.

All the output of silver in 1923 was derived from copper ores and pyritiferous magnetite ores, except 8 ounces derived from siliceous ores and placer bullion.

Mine production of gold and silver in the Eastern States in 1923, by States

State	Gold		Silver		Increase or decrease in value as compared with 1922	
	Fine ounces	Value	Fine ounces	Value	Gold	Silver
Alabama	5.51	$114	1	$1	+$114	+$1
Georgia	25.59	529	2	1	−2,695	−363
North Carolina and South Carolina	68.45	1,415	79	65	−556	+56
Pennsylvania	157.03	3,246	3,005	2,464	+646	+249
Tennessee	320.00	6,615	105,712	86,684	+2,295	+8,343
Virginia					−706	−6
Total, 1922	576.58	11,919	108,799	89,215	−902	+8,280
	620.22	12,821	80,935	80,935		

Mine production of gold and silver in the Eastern States in 1923, by sources, in fine ounces

State	Gold				Silver			
	Placers	Dry and siliceous ores	Copper ores	Lead and copper-lead ores	Placers	Dry and siliceous ores	Copper ores	Lead and copper-lead ores
Alabama	5.51				1			
Georgia	24.82	0.77			2			
North Carolina	3.87	20.41	29.03			4	74	
Pennsylvania			157.03				3,005	
South Carolina	15.14				1			
Tennessee			320.00				105,712	
Total, 1922	49.34	21.18	506.06		4	4	108,791	
	110.78	150.49	334.76	24.19	8	21	80,556	350

COPPER

The mine production of copper in the Eastern States in 1923 was valued at $3,011,647, an increase of $922,320. Of the total output 18,721,932 pounds was derived from Tennessee copper ores and 1,703,480 pounds from Pennsylvania pyritiferous magnetite ore.

The total quantity of ore treated to produce this copper was 1,763,230 short tons. Exclusive of the magnetite ore, which was mined for its iron content and contained very little copper, the average yield of copper from copper ores was approximately 1.21 per cent, or 24.2 pounds to the ton, and this copper ore also yielded $0.12 in gold and silver to the ton. Copper ores directly smelted amounted to 500,169 tons, from which about 12,713,472 pounds of copper was recovered. Copper and pyritiferous magnetite ores concentrated amounted to 1,263,061 tons, which yielded 46,501 tons of concentrates containing 7,773,923 pounds of copper and small quantities of gold and silver. Some copper ore was mined in North Carolina that also yielded gold and silver.

LEAD

The only shipments of lead ores in 1923 were reported by mines in Tennessee.

ZINC

The recoverable zinc in the ore mined in the Eastern States in 1923 was valued at $14,765,885, an increase of $1,148,895. New Jersey produced 150,454,000 pounds, Tennessee 31,800,000 pounds, and New York 16,926,000 pounds. Zinc ore mined and treated amounted to 1,186,131 tons, of which 548,891 tons was from New Jersey, 573,580 tons from Tennessee, and 63,660 tons from New York. Nearly all the zinc ore from Tennessee and New York was sent to concentrating plants, and 488,946 tons of the zinc ore from New Jersey was concentrated and the remainder shipped as crude ore.

REVIEW BY STATES

ALABAMA

The value of the gold produced by mines in Alabama during the period 1830 to 1921 was $766,632.[2] None was reported in 1922.

The value of the gold reported as produced from mines in Alabama in 1923 was $114, from surface placers in Cleburne County. Old properties, such as the Gold Log, Gold Ridge, and other mines in Cherokee, Randolph, and Tallapoosa counties, were idle. Only prospect work was done at the Jemison property, in Chilton County. C. W. Stephens obtained some gold from prospecting near Arbacoochee.

GEORGIA

The value of the gold produced in Georgia during the period 1830 to 1922 was $17,829,190, or more than one-third of the estimated total production of the Southern Appalachian States.

In 1923 mines in Georgia produced 25.59 ounces of gold, valued at $529, and 2 ounces of silver, a decrease of $2,695 in the value of gold and a decrease of 362 ounces in the quantity of silver, as compared with 1922. The gold and silver were obtained from prospect work, and little siliceous ore was milled. Most of the gold was recovered by hydraulicking or sluicing gravels, and operations were spasmodic and small.

Placer production was reported from Cherokee and Lumpkin counties. A little of the placer gold from Cherokee County was derived from small creeks 4 miles north of Canton, but the largest output of placer gold came from the old mines near Dahlonega. The producing placers at Dahlonega were the Lockhart and Barton hydraulic mines, which were worked intermittently.

The deep mines in Georgia yielded only $16 in gold in 1923. A lessee recovered a small quantity of gold from gravel taken from the Standard mine, at Dahlonega, and one or two other placer properties at Dahlonega produced gold. At the Parks mine, in McDuffie County, no ore was mined but the old inclined shaft was repaired and a new shaft was started. At the Magruder mine of the Georgia Copper Co., in Lincoln County, which is opened by a shaft 285 feet

[2] Director of the Mint Ann. Rept. 1922, p. 39.

deep, considerable development work was done and a small quantity of ore was treated by flotation, but the concentrates were not shipped in 1923. Development work only was done at the Turkey Hill mine of Dr. Craig R. Arnold.

MAINE, MARYLAND, NEW HAMPSHIRE, AND VERMONT

No production of gold, silver, or copper was reported in 1923 by mines in Maine, Maryland, New Hampshire, or Vermont. The estimated total gold production of Maryland has been $71,405, none of which has been produced in the last 11 years.

MASSACHUSETTS

The old Chipman mine, at Highfield, Essex County, Mass., which was operated in 1919 by the Merrimac Development Co., was taken over early in 1923 by the United Metals Separation & Refining Co., which reopened the mine and erected a small reduction plant. No metal was shipped in 1923, but shipments of lead were made early in 1924, and the gold and silver is to be refined at the mine when the necessary plant is completed. A brief but comprehensive description of the workings of the mine and the character of the ore, by G. F. Loughlin, is contained in the chapter on gold, silver, copper, lead, and zinc in the Eastern States in Mineral Resources for 1919. Some records of operations from 1872 to 1921 are given in an article by Frederick E. Green.[3]

NEW JERSEY

The production of zinc ore in New Jersey in 1923 was, as usual, confined to the Mine Hill and Sterling mines, at Franklin Furnace, Sussex County, and amounted to 548,891 tons, which contained 150,454,000 pounds of recoverable zinc. The crude ore produced in 1922 amounted to 512,290 tons and contained 147,314,000 pounds of recoverable zinc. Only a part of the zinc ore mined at Franklin Furnace is used directly for the manufacture of zinc. The greater part of this zinc is normally converted into oxide at works in Pennsylvania. For revisions in New Jersey zinc figures, 1918–1920, see page 83.

NEW YORK

The quantity of zinc ore from New York treated in 1923 was 63,660 tons. The concentrates shipped in 1923 contained 16,926,000 pounds of recoverable zinc. The Northern Ore Co., operating the Brown mine, near Edwards, St. Lawrence County, treated most of this ore. One shaft was operated in 1923. None of the pyrite concentrates were sold in 1923. Ore extracted from levels at 800 to 900 feet is dropped to the 900-foot level, hoisted, and trammed by means of a gasoline motor to the mill. The mill, which is constructed of steel and tile, is equipped with crusher, rolls, Dorr thickener, and 17 tables and has a daily capacity of 250 tons. The table concentrates, which assay about 32 to 33 per cent of zinc, are treated by 13 Electric Ore Separating Co. machines, which, by removing much of the pyrite, raise the zinc content to 47 to 48 per cent. These electric machines treat wet concentrates, and to avoid the clogging of the

[3] Vicissitudes of silver mining at Newburyport, Mass.: Eng. and Min. Jour.-Press, March 17, 1923, p. 483.

riffles in the separator and insure their proper operation it is necessary to remove by means of a powerful magnet all the small particles of metallic iron abraded from the rolls and crusher. The average zinc assay of the crude ore treated ranges from 13 to 20 per cent (the average zinc content of the ore in 1923 was 17.09 per cent), and the finished concentrates average about 47 to 48 per cent. A plant for the treatment of tailings, finished in 1922, was operated in 1923, and several new ore bodies were located by diamond drilling. It is estimated that the mine has about 700,000 tons of ore reserves averaging about 20 per cent in zinc content. As the owners have a large tract of land, further drilling will probably add to the reserves. Early in 1924 the mines and mills were acquired by the New York Concentrating Co., with W. R. Wade continuing as manager of the property.

NORTH CAROLINA

The value of the gold produced in North Carolina during the period 1799 to 1922 was $23,634,259. In 1915 the output of gold amounted to $172,001, but since then increased costs of mining and milling the low-grade ore and gravel have made operation so unprofitable that mining has been almost discontinued. Part of the small output of $1,102 in 1923 came from placer mines in Catawba and Stanly counties, and most of the gold from deep mines was derived from the Dixie Queen mine, near Concord, in Cabarrus County, and the Sedberry mine, near Troy, in Montgomery County. Other small producing gold mines were those of the Overton Mining Co., in Randolph County, and the Eastern Development Co. (House mine), in Union County.

None of the deep mines in Moore, Catawba, Davidson, and Rowan counties had any output. Several mines shipped small quantities of copper ore, which yielded about 62,000 pounds of copper. The Dixie Queen mine was the largest producer of copper, and the ore contained considerable gold and a little silver.

PENNSYLVANIA

The Cornwall iron mines, in Lebanon County, Pa., were operated steadily in 1923 by the Bethlehem Steel Co., which produced several thousand tons of a low-grade copper concentrate from pyritiferous magnetite ore. The ore is taken from an open pit, and the copper and sulphur are recovered on Wilfley tables. The concentrate, which was shipped to smelters, contained about 32 per cent of sulphur and a little more than 4 per cent of copper.

SOUTH CAROLINA

Mines in South Carolina produced $5,181,992 in gold during the period 1829 to 1922. The entire output of $32 in gold in 1922 consisted of nuggets picked up on creeks and gullies in Spartanburg County, and that for 1923 was $313 from surface pick-ups by J. D. Plyler, near Lancaster, in Lancaster County. No copper ore was shipped from the mines near Smyrna, in York County, and only a little prospecting was done.

TENNESSEE

The gold produced at mines in Tennessee during the period 1831 to 1922 amounted to $273,922. A large part of the output prior to 1879 was derived from placer mines, but the output since 1906 has been recovered entirely from copper ore mined in Polk County.

The value of all metals mined in Tennessee increased in 1923, though most of the increased total value was due to the larger output and slightly higher price of both copper and lead. The quantity of silver produced was larger, owing to the increased production of copper. The output of zinc was slightly more in 1923 than in 1922.

Mine production of gold, silver, copper, lead, and zinc in Tennessee, 1905–1923

Year	Ore sold or treated	Gold	Silver	Copper	Lead	Zinc	Total value
	Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1905–1914	6,401,574	$57,630	808,443	182,379,746		42,662,808	$30,483,771
1915	1,149,364	6,862	100,543	18,046,010	1,660	32,922,902	7,298,406
1916	1,184,821	5,739	94,701	14,679,794	32,960	52,855,480	10,764,189
1917	1,533,983	5,326	99,053	16,033,749	5,061,937	56,995,107	10,712,985
1918	1,159,971	4,866	93,620	14,799,680	3,410,400	42,141,311	7,831,005
1919	1,227,534	5,662	98,288	15,623,589	4,376,000	46,494,000	6,647,723
1920	1,120,995	5,830	110,719	16,727,803	3,957,000	38,434,000	6,634,144
1921	889,122	4,920	98,762	15,084,294		19,384,000	3,018,756
1922	983,844	4,320	78,341	14,240,571	1,464,000	31,136,000	3,860,410
1923	1,355,547	6,615	105,712	18,721,932	2,500,000	31,800,000	5,182,823
	17,006,755	107,770	1,688,182	326,337,168	20,803,957	394,825,608	92,434,212
Increase, 1923	371,703	2,295	27,371	4,481,361	1,036,000	664,000	1,322,413

Polk County.—The entire output of copper, gold, and silver in Tennessee came from the two large copper mines in the Ducktown district, and the production of all three metals was more in 1923 than in 1922. The Tennessee Copper Co. operated its flotation plant, 2,000-ton smelter, converter, sulphuric acid plant, and copper sulphate plant on crude sulphide ores from the Burra Burra and London mines. The pig copper was shipped to the Baltimore Copper Smelting & Refining Co. and the Nichols Copper Co. for refining.

The Ducktown Sulphur, Copper & Iron Co. operated one 600-ton blast furnace and 12-foot converter on self-fluxing sulphide ore and concentrates from the Mary mine, at Ducktown. Part of the crude ore was concentrated at the 500-ton flotation plant. The Mary mine is opened by a 1,200-foot vertical shaft, and the East Tennessee mine by a 700-foot shaft.

Most of the zinc produced was obtained from the Embree mine, in Washington County, and the Mascot mine, in Jefferson County, as the mines of the Union Zinc Co., in Union County, of the Tennessee Zinc Co., in Claiborne County, and of the Grasselli Zinc Co., in Jefferson County, were idle. The Embree Iron Co. operated the Embree mine, which produces zinc carbonate and lead carbonate ores. Part of the zinc ore is shipped directly from the mines, and part is concentrated by means of log washers and tables. The dried crude zinc ore and concentrates contained 42.27 per cent of zinc. Some galena ore was concentrated by means of jigs and tables into a product averaging about 67.78 per cent of lead. In addition to ore mined in 1923, lead and zinc ores mined in previous years were shipped.

The American Zinc Co. of Tennessee continued its steady operation of the Mascot mine. The sulphide ore was hoisted from the mine through the 180-foot and 525-foot shafts. The concentrating plant is equipped with Cooley jigs, tables, and oil flotation and has a capacity of 100 tons an hour. A new plant equipped with an Oliver filter and Lowden patent dryer for drying flotation concentrates was built in 1923.

VIRGINIA

The mines of the Bertha Mineral Co., at Austinville, Va., were operated for a short period in 1923, but no zinc concentrates were shipped.

The Helen Mineral Co., at Ivanhoe, in Wythe County, was idle. No recoveries of gold and silver were reported from the smelting of pyritic ores or from siliceous ores. The R. E. Dolan property, near Mineral, Louisa County, was idle, and no mines reported the production of any gold or silver in 1923. The value of gold produced from mines in Virginia during the period 1828 to 1922 was $3,298,032, of which less than $9,000 was recovered during the last 12 years of that period. The deep and placer gold mines in Albemarle, Floyd, Fauquier, Goochland, and Fluvanna counties yielded about half of this total; the remainder of the gold was derived from cinders of pyritic ores or copper ores shipped to smelting plants.

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PLATINUM AND ALLIED METALS

By James M. Hill [1]

PRODUCTION

CRUDE PLATINUM

Mine returns for 1923 indicate a production of 7 troy ounces of crude placer platinum in Alaska, 578 ounces in California, and 24 ounces in Oregon, a total of 609 ounces for the United States. In 1922 Alaska produced 39 ounces, California 916 ounces, and Oregon 53 ounces.

Platinum refiners report purchases of domestic platinum in 1923 as follows: Alaska, 29 ounces; California, 707 ounces; Oregon, 63 ounces; Washington, 1 ounce—a total of 800 ounces, which is 258 ounces less than was purchased by refiners in 1922. Refiners also report purchases of 54,741 ounces of foreign crude platinum in 1923, including 1,007 ounces from Australia, 10 ounces from Canada, 48,727 ounces from Colombia, and 4,997 ounces from Russia. As reported by the Bureau of Foreign and Domestic Commerce, Department of Commerce, the imports of platinum from Colombia during 1923 were 32,278 ounces, and the total imports of unmanufactured platinum 86,417 ounces, a decrease of 9 per cent, as compared with imports in 1922.

REFINED PLATINUM METALS

NEW METALS

Reports of refiners of crude platinum, gold bullion, nickel, and copper indicate that 49,797 ounces of platinum metals were recovered from these sources in 1923, a decrease of 7,921 ounces as compared with the recoveries in 1922. It is estimated that of the total quantity, 3,472 ounces was derived from domestic sources.

New platinum metals recovered by refiners in the United States in 1919-1923, in troy ounces

Year	Platinum	Palladium	Iridium	Osmiridium	Others	Total
1919	40,220	3,807	401	402	279	45,109
1920	36,015	4,309	418	409	393	41,544
1921	51,791	2,686	286	581	1,026	56,370
1922	54,142	1,943	210	1,301	122	57,718
1923	46,780	1,934	280	787	16	49,797

[1] Miss Helen M. Gaylord, of the United States Geological Survey, assisted in the preparation of this report.

New platinum metals recovered by refiners in the United States in 1922-23, by sources, in troy ounces

Year	Platinum	Palladium	Iridium	Osmiridium	Others	Total
1922						
Domestic:						
Crude	297		71	512	11	891
Gold and copper refining	1,701	777	4			2,482
	1,998	777	75	512	11	3,373
Foreign:						
Crude	51,764	525	114	789	7	53,199
Gold, nickel, and copper refining	380	641	21		104	1,146
	52,144	1,166	135	789	111	54,345
Total recovery	54,142	1,943	210	1,301	122	57,718
1923						
Domestic:						
Crude	247		42	91	5	385
Ore	2	11				13
Gold and copper refining	1,865	1,176	33			3,074
	2,114	1,187	75	91	5	3,472
Foreign:						
Crude	44,318	255	205	696	11	45,485
Ore	32					32
Gold, nickel, and copper refining	316	492				808
	44,666	747	205	696	11	46,325
Total recovery	46,780	1,934	280	787	16	49,797

SECONDARY METALS

Secondary platinum metals are those recovered from the treatment of scrap metal, sweeps, and other waste products of manufacture that contain platinum. Although the figures given in the following table undoubtedly contain some duplication, it is believed that they are worth publishing, for the secondary metals constitute a considerable proportion—21 per cent in 1923—of the total platinum metals available for consumption in the United States.

Secondary platinum metals recovered in the United States, 1919-1923, in troy ounces

Year	Platinum	Palladium	Iridium	Others	Total
1919	54,545	3,467	3,504		61,516
1920	51,255	3,100	3,355		57,710
1921	39,131	4,887	1,776	229	46,023
1922	40,062	4,193	1,937	496	46,688
1923	39,152	6,246	2,021	453	47,872

IMPORTS AND EXPORTS [1a]

The imports of platinum metals for consumption in 1923 were approximately 3 per cent less in quantity than in 1922 and 36 per cent greater than in 1921.

Platinum metals imported for consumption in the United States, 1922–23

Metal	1922		1923	
	Troy ounces	Value	Troy ounces	Value
Platinum or crude platinum and unmanufactured products, ingots, sheets, wire, etc.	94,939	$7,790,898	86,417	$8,923,037
Platinum, manufactured products, vases, retorts, etc [a]	45	[b] 11,464	103	4,769
Iridium	1,899	298,567	1,611	276,539
Osmiridium	2,165	242,637	1,174	150,074
Osmium	1,012	81,231	1,462	147,154
Palladium	9,754	537,684	14,578	857,071
Rhodium	111	16,227	805	86,569
Ruthenium	100	4,839	487	21,492
	110,025	8,983,547	106,637	10,466,705

[a] Classification in 1923 is "Manufactures of, except jewelry."
[b] Includes articles to the value of $6,735 (quantity not given), imported under duty Jan. 1 to Sept. 21, 1922.

Platinum metals imported into the United States in 1923, by countries, in troy ounces [a]

[General imports]

Country	Platinum grains, scrap, ingot, etc.[a]	Palladium	Iridium	Osmium and osmiridium	Rhodium and ruthenium	Total
Argentina	10					10
Australia				216		216
Belgium	1					1
Brazil	86					86
British South Africa	1,396		160			1,556
Canada	357	297				654
China	147					147
Colombia	32,278	28	20	54		32,380
Dutch Guiana	45					45
England	22,530	12,993	801	1,395	741	38,460
Esthonia	740					740
France	7,781	803	630	245	551	10,010
Germany	11,984	457		721		13,162
Latvia	1,951					1,951
Mexico	43					43
Netherlands	691					691
Panama	679					679
Russia in Europe	493					493
Sweden	5,205			5		5,210
	86,417	14,578	1,611	2,636	1,292	[a] 106,534

[a] Exclusive of 103 ounces of platinum in manufactures.

The metal imported from Panama and Colombia (33,059 ounces) is crude, and the imports from Esthonia, Latvia, and Sweden are believed to be crude and of Russian origin, the total platinum from Russia being 8,389 ounces. Part of the metal from England, France, and Germany is doubtless Russian crude, but the bulk is probably refined metal.

[1a] The data for imports and exports were compiled by J. A. Dorsey, of the United States Geological Survey, from the records of the Bureau of Foreign and Domestic Commerce, Department of Commerce.

Platinum exported from the United States, 1919–1923

Year	Unmanufactured		Manufactures of, except jewelry	
	Troy ounces	Value	Troy ounces	Value
1919	522	$75,066	(a)	$54,529
1920	1,302	177,115	(a)	111,014
1921	3,272	244,473	741	85,216
1922 Crude, scrap, and old	143	13,149	486	35,967
1922 Ingots, sheets, wire, and alloys	1,313	127,047		
1923	1,151	128,599	592	65,073

a Quantity not given.

The largest exports of platinum ingot, sheet, and alloys in 1923 went to France, Canada, and Argentina (500, 404, and 140 troy ounces, respectively), and Canada and Argentina took the bulk of the manufactured platinum (439 and 119 troy ounces, respectively).

CONSUMPTION

The consumption of platinum metals in the United States in 1923, as reported by refiners, was 190,783 ounces, an increase of 4 per cent over 1922. The dental industry increased its consumption of platinum, palladium, and iridium. In the jewelry industry there was a large increase in the consumption of iridium and a still greater increase in palladium. Osmium is being used in increasing amounts for the preparation of an alloy that is substituted for native osmiridium for pointing gold pens.

It has been found impossible to reconcile the figures showing the consumption of 190,783 ounces of the platinum metals, as given by refiners, with those showing the apparent consumption of 153,011 ounces, as calculated by the method used in preparing the second table below or by any variants of that method. It is believed that there is considerable duplication in the figures for consumption given by refiners, but so far no means have been found to avoid this source of error, and the figures thus supplied give the only measure of consumption by industries. In the method of calculation used in determining the "apparent supply" there is a source of error in the assumption of the quantity of platinum imported in the refined state. Nevertheless, this method is believed to give a fair measure of the quantity of platinum metals consumed. It seems probable that the actual consumption was about 175,000 ounces.

Platinum metals consumed in the United States as reported by refiners, 1922–23, by industries, in troy ounces

Industry	Platinum	Iridium	Palladium	Others	Total	Percentage of total
1922						
Chemical	8,834	172	458	271	9,735	5
Electrical	24,988	1,537	2,735		29,260	16
Dental	11,651	83	5,535		17,269	10
Jewelry	108,527	2,588	9,852	1,190	122,157	67
Miscellaneous	2,838	1,064	636		4,538	2
	156,838	5,444	19,216	1,461	182,959	100
1923						
Chemical	8,637	190	485	266	9,578	5
Electrical	18,596	1,675	3,666		23,937	13
Dental	16,288	153	10,116		26,557	14
Jewelry	105,699	3,073	14,948	190	123,910	65
Miscellaneous	3,156	1,403	986	1,256	6,801	3
	152,376	6,494	30,201	1,712	190,783	100

Apparent supply of platinum metals in the United States in 1922–23, in troy ounces

	Platinum	Iridium	Palladium	Others	Total
1922					
Stocks January 1, 1922	38,514	4,991	21,042	3,113	67,660
New metal produced, 1922	54,142	210	1,943	1,423	57,718
Secondary metal produced, 1922	40,062	1,937	4,193	496	46,688
Imports	[a] 31,457	1,899	9,754	3,388	46,498
Total available	164,175	9,037	36,932	8,420	218,564
Stocks January 1, 1923	41,900	7,559	24,975	1,583	76,017
Apparent supply	122,275	1,478	11,957	6,837	142,547
Exports	1,942				1,942
Apparent domestic consumption	120,333	1,478	11,957	6,837	140,605
1923					
Stocks January 1, 1923	41,900	7,559	24,975	1,583	76,017
New metal produced, 1923	46,780	280	1,934	803	49,797
Secondary metal produced, 1923	39,152	2,021	6,246	453	47,872
Imports	[a] 31,676	1,611	14,578	3,928	51,793
Total available	159,508	11,471	47,733	6,767	225,479
Stocks January 1, 1924	36,554	5,208	26,266	2,697	70,725
Apparent supply	122,954	6,263	21,467	4,070	154,754
Exports	1,743				1,743
Apparent domestic consumption	121,211	6,263	21,467	4,070	153,011

[a] Platinum "imported for consumption" less foreign crude platinum purchased by refiners is taken to be refined platinum imported.

STOCKS

Stocks of the platinum metals in the hands of refiners on December 31, 1923, amounted to 70,725 ounces, a decrease of 7 per cent as compared with the stocks at the beginning of the year.

Stocks of platinum metals in the hands of refiners in the United States December 31, 1919–1923, in troy ounces

Metal	1919	1920	1921	1922	1923
Platinum	29,228	46,747	38,514	41,900	36,554
Iridium	3,359	4,196	4,691	7,559	5,208
Palladium	10,235	16,565	21,042	24,975	29,266
Others	610	216	3,113	1,583	2,697
	43,432	67,724	67,360	76,017	73,725

MARKET AND PRICES

CRUDE PLATINUM

Sellers of domestic crude platinum reported having received from $75 to $105 an ounce for their product in 1923, and the average for all crude platinum reported was $104 an ounce. Buyers reported purchases at a rate of $95 to $113 an ounce for domestic and $90 to $112 for foreign crude platinum. Buyers of foreign and domestic crude platinum in the United States who reported purchases in 1923 are listed below:

American Platinum Works, 325 New Jersey Railroad Avenue, Newark, N. J.
Baker & Co. (Inc.), Murray and Austin streets, Newark, N. J.
J. Bishop & Co., Malvern, Pa.
Sigmund Cohn, 44 Gold Street, New York, N. Y.
Goldsmith Bros. Smelting & Refining Co., 20 John Street, New York, N. Y.
S. B. Gracier (Inc.), 608 Commercial Street, San Francisco, Calif.
Martin Hannum Refining Co. (Pacific Platinum Works), 814 South Spring Street, Los Angeles, Calif.
Interstate Smelting & Refining Co., 29 Commercial Street, Newark, N. J.
Johnson Matthey & Co., Woolworth Building, New York, N. Y.
Kastenhuber & Lehrfeld, 24 John Street, New York, N. Y.
National Smelting & Refining Co., 92 John Street, New York, N. Y.
R. & H. Platinum Works, 709 Sixth Avenue, New York, N. Y.
Shreve & Co., Post Street and Grant Avenue, San Francisco, Calif.
Wildberg Bros., 742 Market Street, San Francisco, Calif.
H. A. Wilson Co., 97 Chestnut Street, Newark, N. J.

REFINED METALS

The quoted prices[2] for refined platinum remained within the limits of $110 to $125 an ounce throughout the year; they were lowest in February and March, and it is believed that the average selling price for the year was $116. Iridium began the year at $240 to $275 an ounce but rose to $275 to $300 by July and continued at that level until the end of the year; the average selling price was approximately $280. Palladium opened the year at $65 an ounce and rose to $83 in December; the average selling price was $77.

The 5 per cent iridium alloy sold at an average of $126 an ounce, and the 10 per cent alloy at $134 an ounce; the highest prices reached were $134 and $143, and the lowest $118 and $126, respectively.

[2] Eng. and Min. Jour.-Press, vols. 114, 115, 1923.

WORLD'S PRODUCTION

Estimated world's production of crude platinum from placers, 1914–1922, in troy ounces

Country [a]	1914	1915	1916	1917	1918	1919	1920	1921	1922
Australasia:									
New South Wales [b]	244	56	82	259	607	213	796	249	80
Papua [c]	(c)	(c)	(c)	(c)	(c)	(c)	100	360	100
Tasmania [d]	1,019	247	222	332	1,607	1,670	2,009	1,751	1,174
British India [e]	37	18	9	4	(f)				
Canada [g]	30	100	60	80	40	30	25	15	15
Colombia [h]	17,500	18,000	25,000	32,000	35,000	35,000	35,000	35,500	40,000
Japan [i]			70	127	51	155	258	231	(j)
Russia [h]	241,200	124,000	63,900	50,000	25,000	30,000	35,000	20,000	22,000
Union of South Africa [k]	(j)	(j)	(j)	(j)	(j)	(j)	(j)	510	762
United States	570	742	750	605	647	824	613	977	1,008

[a] In addition to the countries listed, Brazil exported 700 grams (23 ounces) in 1915.
[b] New South Wales Dept. Mines Ann. Repts.
[c] Territory of Papua Mines Dept. Rept. (production osmiridium, year ending June 30). Prior to 1920 annual production had not exceeded 10 ounces.
[d] Tasmania Dept. Mines Ann. Repts. (Tasmanian production all osmiridium.)
[e] India Geol. Survey Records.
[f] Production 0.31 ounce.
[g] Estimate by J. M. Hill; Canada Dept. Mines Ann. Repts. give the following figures (believed low): 1914, none; 1915, 23; 1916, 15; 1917, 57; 1918, 39; 1919, 25; 1920, 17. 1921: Imperial Mineral Resources Bureau, London, 23; 1922: Dominion Bureau of Statistics, 12.
[h] Estimate by J. M. Hill.
[i] Agricultural and commercial statistics of Japan.
[j] Data not available.
[k] Dept. Mines and Industry Ann. Rept. (osmiridium).

The following tables give data by which the figures showing the production of crude platinum as given above can be reduced to terms of the refined metals used by the industries:

Average assay of crude platinum, in per cent

Country	Platinum	Palladium	Iridium	Osmium	Rhodium, ruthenium, etc.
Australasia:					
New South Wales	75.9		1.3		1.3
Papua			58.1	33.5	3.0
Tasmania			58.1	33.5	3.0
Canada	72.1	0.2	1.1		2.8
Colombia	96.2	.5	1.1		1.4
Japan	.2		49.8	37.3	3.9
Russia	83.5	1.9	1.9	3.0	.6
United States	85.5	.6	1.1	1.3	1.0

Platinum metals contained in crude platinum produced in different countries in 1921, in troy ounces

Country	Crude platinum	Calculated content of platinum metals					
		Platinum	Palladium	Iridium	Osmium	Rhodium, ruthenium, etc.	Total
Australasia:							
New South Wales	249	189		3		3	195
Papua	360			209	121	11	341
Tasmania	1,751			1,017	587	53	1,657
Canada	15	11	(a)	(a)		(a)	11
Colombia	35,500	34,151	178	391		497	35,217
Japan	231	(a)		115	86	9	210
Russia	20,000	16,700	380	380	600	120	18,180
United States	977	835	6	11	13	10	875

[a] Less than half an ounce.

PROPOSED STATUTORY DEFINITION OF PLATINUM

Recently there has been some discussion in the jewelry trade papers relative to the enactment of a law prescribing what alloys may be stamped "platinum." The jewelry industry is not entirely agreed as to just what should be classed as platinum. One group wishes to include nothing but the platinum-iridium alloy; another to allow all alloys carrying 75 per cent or more of platinum metals to be so classed; and a third to include all white alloys containing any of the platinum metals.

Mr. Engelhard,[3] of Baker & Co. (Inc.), has supplied valuable data bearing on this subject, with particular reference to the metallurgical phases, and states the position of one of the largest refiners in the country as follows:

> We are in favor of a law to restrict the use of by-metals to, say, 25 per cent, and any piece of jewelry can be called platinum if it contains at least 75 per cent platinum by-metals, whatever they are. If the percentage of platinum itself is less, then the restrictions as indicated in the proposed law should commence.

At a meeting of the American National Retail Jewelers' Association on October 16, 1923, the following resolution was passed:[4]

> *Resolved*, That it is the sense of this meeting that, for the protection of the public and for the best interests of the jewelry industry, there should be adopted certain definite and workable standards which shall form a basis for the stamping of platinum articles, which are as follows:
>
> ARTICLE I. Articles consisting of not less than $\frac{950}{1000}$ parts pure platinum where solder is used, or $\frac{985}{1000}$ pure platinum where solder is not used, may be marked "platinum" (abbreviated "plat."), and sold as platinum.
>
> ARTICLE II. Articles consisting of 95 per cent of the metals of the platinum group and at least 75 per cent pure platinum where solder is used, or 98 per cent of the metals of the platinum group and at least 73 per cent of pure platinum where solder is not used, may be sold and marked with the word "platinum," immediately preceded by the name of the other chief ingredient by weight, of the platinum group, or its abbreviation, namely, "iridium-platinum" (abbreviated "irid-plat"), "palladium-platinum" (abbreviated "pall-plat"), "osmium-platinum" (abbreviated "osm-plat"), "rhodium-platinum" (abbreviated "rho-plat"), "ruthenium-platinum" (abbreviated "ruth-plat").
>
> ARTICLE III. Articles containing less than $\frac{750}{1000}$ parts of pure platinum may not be stamped with the word "platinum" or any simulation or abbreviation of the name "platinum."

METALLURGY

The Bureau of Mines[5] has issued a report giving detailed information on methods for the recovery of several metals of the platinum group from waste products of manufacture. This report states that

> Although the necessary manipulations and the chemical procedures are discussed in a rather elementary manner in order to enable persons who have had only a little laboratory experience to use some of the methods, the separation and recovery of the platinum metals is intricate and should be performed only by a skilled chemist. For this reason it is advisable either to employ such a chemist or to ship the material to one of the many refiners of platinum.

In view of the numerous attempts made late in 1922 and early in 1923 to float platinum-mining ventures based on incorrect assays, the Bureau of Mines has published the results of a series of check assays on material supposed to contain platinum.[6] Certain portions

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[3] Engelhard, Charles, An open letter on the subject of platinum: Jewelers Circ., vol. 86, p. 63, June 20, 1923.

[4] Jewelers Circ., vol. 87, p. 87, Oct. 24, 1923.

[5] Davis, C. W., Methods of the recovery of platinum, iridium, palladium, gold, and silver from jewelers' waste: U. S. Bur. Mines Tech. Paper 342, 1924.

[6] Lind, S. C., Davis, C. W., and Von Bernewitz, M. W., Platinum assays and platinum promotions: U. S. Bur. Mines Repts. Inv. 2496, July, 1923.

of the report are quoted below to emphasize the necessity for the employment of only the most competent assayers in determining the platinum metals.

> The recognition, separation, and correct determination of platinum in small quantities, particularly in lode material, is by no means simple. No rough method will do, even for detection, because of the small quantities involved. As the methods employed are usually those of fire assay, similar to those used for gold and silver, the prospector or others would naturally seek custom assayers for the determination of platinum. * * * Incorrect platinum returns have been made by chemists who have fanciful methods, rather than to any difficulty with the standard method.
>
> * * * * * * *
>
> The only other service that the bureau can render in connection with platinum and platinum metals is in warning the mining industry and the general public, as far as possible, as to mistaken or fraudulent platinum returns or promotions. While the ethical and legal aspects are quite different, economically it makes no difference whether erroneous returns have as a basis merely honest mistakes or fraudulent intent—both result equally in an ultimate loss.
>
> The growing seriousness of the situation has suggested to various State mining officials in the Western States the necessity of taking some action to protect the public. Legal prosecution has been considered but not hitherto employed, owing to the lack of sufficient laws to reach the cases, also to the difficulty of securing evidence of the necessary character. Legislative relief has been considered in the form of a law requiring the licensing and examination of assayers, and the so-called "blue sky" laws have also been considered as a possible remedy.
>
> In general, it may be stated that little or no progress has been made toward the eradication of the evil. It is not our purpose to suggest a remedy. As is well known, the Bureau of Mines has no police powers, and the Interior Department has always regarded such matters as subject for State rather than Federal legislation, except so far as the postal laws may be violated in the distribution of fraudulent literature.

REVIEW BY STATES

In California the production of crude platinum declined materially in 1923, only 578 ounces being produced, as compared with 916 ounces in 1922. This decrease was due in part to the fact that the Shasta dredge, on Cottonwood Creek, Shasta County, had worked out its ground and been abandoned in August, 1922. The dredges in Sacramento and San Joaquin valleys were about as productive as usual. The total recovery of crude platinum by dredges in California in 1923 was 576 troy ounces, which was obtained from 48,190,740 cubic yards of gravel, indicating a recoverable content of 0.00001195 ounce of platinum to the cubic yard. Low water in the Klamath Mountains resulted in smaller placer operations and a lessened output of platinum from small operators, though there was some activity in the Peanut and Hayfork regions of Trinity County.

In Oregon practically all the platinum output was saved by beach miners near Bullards and Sixes, in Coos and Curry counties. The Illinois and Rogue River placers, in Jackson and Josephine counties, were worked very little, owing to a lack of water. No recovery of platinum was recorded by the placer miners of the John Day or Blue Mountain sections of eastern Oregon.

The Rambler mine, near Laramie, Wyo., was operated and shipped some palladium-bearing concentrates to eastern smelters. Considerable advertising has been given to the reported discovery of platinum in the Centennial district, but statements from reliable authority have been withheld pending further investigation when the country is open after the winter.

There have been less than the usual number of platinum promotions in 1923, probably owing to the exposure of the Coeur d'Alene fake of 1922 and of the operations of certain assayers by the Bureau of Mines. The Mono Lake affair is still heard from occasionally, and prospectors in the Cle Elum district, Washington, and the Gardnerville district, Nevada, seem to be working under the delusion of incorrect assays.

FOREIGN PLATINUM DEPOSITS

AUSTRALASIA

It is reported [7] that from the working of 300 to 400 yards of gravel on Yodda and Gira rivers, in Papua, during the year ending June 30, 1921, 208 ounces of osmiridium was saved, as well as some gold. More thorough prospecting of the Province of Papua would seem to be warranted by the world shortage of osmiridium.

The Minister of Mines of Tasmania has been investigating the possibility of the continuation of Government control of the osmiridium output of the Province. Reports [8] indicate that the miners are favorably inclined toward the continuation of the present method of paying 60 per cent of the estimated value upon the delivery of osmiridium and the remainder upon sale abroad.

Declared exports [9] of osmiridium from Adelaide, Melbourne, and Sydney to the United States in 1921 and 1922 were 1,813 ounces, valued at $252,710, and 1,155 ounces, valued at $168,199. respectively.

CANADA

The production of platinum metals at the refinery of the International Nickel Co., Port Colborne, Ontario, for the year 1922 [10] was 176.18 ounces of platinum, 341.44 ounces of palladium, and 124.44 ounces of rhodium, ruthenium, osmium, and iridium, of which the rhodium was by far the most abundant.

Tests made by the Canadian Department of Mines [11] show that the gold and platinum metals contained in the Sudbury ores follow the nickel-copper concentrate in the flotation-concentration mill.

The presence of platinum and palladium in copper-nickel ores from the Shebandowan Lake district, Ontario, was also demonstrated, but results are not promising.[12]

COLOMBIA

The estimated output of crude platinum in Colombia in 1922 was about 40,000 ounces, and it is believed that in 1923 about 43,000 ounces was produced. Figures supplied by the Colombian Government Information Service in New York indicate that the total exports of crude platinum from Colombia in 1923 were 42,283 ounces, of which 25,784 ounces was shipped through Buenaventura and the rest through Cartagena.

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[7] Min. Jour. (London), vol. 141, p. 276, Apr. 14, 1923.
[8] Idem, vol. 140, p. 158, Feb. 24, 1923.
[9] Suppl., Commerce Repts., Trade and Econ. Rev. 1922, No. 18, Australia, Nov. 18, 1923.
[10] Eng. and Min. Jour.-Press, vol. 115, p. 627, Apr. 7, 1923.
[11] Summary Rept. Mines Branch Inv., calendar year 1922, Test 184, pp. 192–193.
[12] Idem, Test 172, p. 157.

The South American Gold & Platinum Co.[13] produced 15,259 ounces of platinum in 1922 and 7,697 ounces during the first eight months of 1923. This decrease in recovery of more than 5,000 ounces compared with that for the corresponding period of 1922 was caused by the fact that the No. 1 dredge did not get back to work until June, 1923, and that at times the No. 3 dredge could not be supplied with fuel on account of low water. The construction of the hydroelectric plant was also delayed because of low water, and the plant was not placed in operation in 1923. This plant is designed to care for several additional dredges.

During 1922 the British Gold & Platinum Corporation (Ltd.) worked one boat which dug 314,700 yards and produced 1,885 ounces of platinum and 657 ounces of gold. The launching of No. 2 dredge was delayed until October 4, 1922, because of low water.[14] In the four weeks ending July 28, 1923, this company produced 542 ounces of platinum,[15] and in the four weeks ending October 20 it produced 443 ounces.[16]

The Columbia Platinum & Gold Dredging Co.,[17] of Los Angeles and San Francisco, holding several concessions covering 155,000 acres on San Juan River below the Tamana and near Noanama and on Sipi River near Sipi, has not yet begun production.

RUSSIA

The production of platinum in Russia in 1922 is estimated at 22,000 ounces, though figures ranging from 20,000 to 28,000 ounces have been mentioned. The production from October 1, 1922, to September 1, 1923, is stated[18] as 60.5 poods, equivalent to 31,862 ounces.

Botsford[19] has given information concerning the present situation in the Russian platinum field in a paper from which the following extracts are given:

> During 1922 the operators in the Urals, who had combined in a so-called platinum trust, expected to produce about 2,340 pounds of crude platinum, but the amount actually recovered during that season was reported as only 1,620 pounds, most of which came from hand workings; Nicolo Pavda had the principal dredges in operation during that year. In preparation for 1923 operations, about $400,000 worth of repair parts were obtained in England. At least two American-built dredges and one Putiloff dredge are reported in operation at Nicolo Pavda, and it is supposed that most of the better dredges in the platinum district are now working.
>
> * * * * * * *
>
> In 1918 there were 24 dredges in operation, capable of producing about 5,000 pounds of platinum per season. Nearly all have had to shut down for lack of repair parts. Some will be advantageously replaced by more modern dredges of larger capacity and equipped for more economical operation.
>
> A number of factors influence the proposals to extend the installation of dredges in the Urals. First is that their cost of operation is very much smaller, per cubic yard handled, than that of even the best conducted hand operation. The advancing price of platinum is also an important consideration. Furthermore, dredges have an advantage over any hand operations in that their recovery can be more carefully guarded; in fact, even the material being excavated is inaccessible to all but the dredge operator. The richer ground which could be

[13] Letter to stockholders dated Oct. 8, 1923.
[14] Min. Jour. (London), vol. 140, p. 19, 1923.
[15] Idem, vol. 142, p. 616, Aug. 11, 1923.
[16] Idem, vol. 143, p. 837, Nov. 3, 1923.
[17] Prospectus entitled "The romance of platinum," issued in 1923.
[18] Min. Jour. (London), vol. 143, p. 775, Oct. 13, 1923.
[19] Botsford, R. S., Platinum in the Urals: Min. and Metallurgy, vol. 4, pp. 595–600, 1923.

exploited by hand methods has practically all been gone over once, except possibly certain areas where the primitive methods were inadequate owing to the presence of large amounts of water. On the Jov River there is some unworked ground which might be suitable for hydraulicking, and along the Iss River are some bench placers above the level of the river.

The principal hope of extending the platinum districts lies toward the north; the country to the south of the known districts has been thoroughly examined and mapped, while the areas to the north are practically unknown. Prospecting parties from Bogoslovsk have returned from the north without finding either dunite or platinum in any great amount. They reported the finding of loose geodes, the filling of which was found to be iron rust and clay and several ounces of loose platinum grains. A little later Professor Duparc penetrated farther north with a party whose route was much curtailed by their inadequate means for transporting food; they reported the finding of dunite, but its basic constituent proved to be magnetite instead of chromite, and they found no platinum.

The London Mining Journal [20] has also given information concerning the Russian situation which should interest all those in the platinum industry:

The new economic policy in the platinum industry was seen in the formation of the Ural platinum trust, the principal object of which was the revival and development of the platinum industry to correspond to the general interests of Russia's political economy.

At the same time a plan was prepared for three years' activity, providing for a net profit of 3,500,000 gold rubles in the year 1924; whilst, however, this plan was based, amongst other things, on the following two conditions—the issue of supplementary capital amounting to 1,239,000 gold rubles, and complete payment of the production of the trust at the price of the London market. Neither condition was observed. Not a ruble was given, as a matter of fact, and the payment of the production of the trust in the first year amounted to 60 per cent and in the second year to 57 per cent only of the London prices. With this method of payment, the net profit of the Public Finance Committee for the two years of the existence of the Ural platinum trust exceeded 4,000,000 gold rubles. But of course it is obvious, under the conditions projected when the trust was formed, the scheme of developing the production by way of the subsequent revival of the dredging system could not be carried out.

Nevertheless, the trust, having begun work with 10 dredges in the first year of its existence, now disposes of 23. During the current working year 5 of them have been restored and 2 new ones have been built, of which 1 is electric. Here it is necessary to observe that these dredges did not work throughout the whole period. Their repair takes place usually during the winter, and they start work in the summer. The book year begins in October, and so it is only in the coming season that all the dredges will be working normally.

TRANSVAAL

A report of the platinum discoveries in the Waterberg area, 100 miles north of Pretoria, Transvaal, has been given out by the Transvaal Geological Survey.[21] Excerpts from this report are given below.

The farm on which the actual discovery was made, Welgevonden No. 1772, was prospected in the early days and, as it was supposed to contain gold, was proclaimed a public gold field in the year 1893. A good deal of prospecting was done on it, but as in 1905 no claims were held, it was deproclaimed. In 1908, during the tin boom that followed the discovery of Zaaiplaats, the farm was again prospected, and tin was found in such quantities that the Welgevonden tin mine was floated and worked until 1913, when the deposits gave out.

The Transvaal Platinum (Ltd.) was formed by Mr. Baumann to work this and all or part of the following adjoining properties: Rietfontein No. 1638, Rietfontein No. 3, Doornhoek No. 896, Kromkloof No. 1637, Geelhoutkloof No. 2122, Magalakynsoog No. 381, Zuikerboschfontein No. 1015, and Doornkom No. 1807. Since then six other companies have been formed to work adjoining properties,

[20] State of platinum industry in Russia: Min. Jour. (London), vol. 143, p. 858, Nov. 10, 1923.
[21] Min. Mag. (London), vol. 30, pp. 111-114, January, 1924 (copied from South African Jour. Industries).

namely, New Platinum (Ltd.), which holds an option over the southern part of Geelhoutkloof No. 2122; Rietfontein Platinum Prospecting Syndicate (Ltd.), which holds an option over the central part of Rietfontein No. 3; Platinum Farms (Ltd.), which holds options over a number of farms in the area containing the platinum deposits; Nylstroom Platinum (Ltd.), which holds an option over the southwestern part of Rietfontein No. 3 and several of the adjoining farms; Waterberg Platinum (Ltd.); and Central Platinum (Ltd.).

The prevailing rock is the well-known felsite of the Waterberg area. * * *

In the eastern part of the area the felsite is unconformably overlain by horizontally bedded pink Bushveld sandstone, the equivalent of the Cave sandstone of the Stormberg series of the Karroo system. * * *

In the western part of the area the Bushveld sandstone has been removed by denudation, and here the felsite is overlain, again unconformably, by purple Waterberg conglomerate and sandstone, dipping at angles of 15°–50° N. The felsite itself is underlain by red Bushveld granite, which bears an intrusive relation toward it. The Bushveld granite is well exposed on Rietfontein No. 1638 and is the country rock of the main lode on the central part of that farm. Where the principal workings are situated the granite-felsite contact probably lies fully 500 feet below the surface.

Throughout the area there is evidence of considerable crustal disturbance, which finds expression in numerous powerful faults striking in various directions, the prevalent one being northeast to southwest. Most of the faults are shown on Mellor's maps, and he was also the first to recognize that some of them are of post-Karroo age, having brought Bushveld sandstone into juxtaposition with felsite. It is with the post-Karroo faults that we are more particularly concerned, as the main lode occupies one of them. * * *

The main platinum lode first opened up on Rietfontein No. 3 occupies a post-Karroo fault. It can be traced at the surface without a break for a distance of about 2½ miles from the central part of Rietfontein No. 1638 through the northeast corner of Rietfontein No. 3 into Welgevonden No. 1772. In the southern part of Welgevonden it is no longer to be seen, and there is either a break here or the lode comes to an end. Near the boundary fence of Welgevonden No. 1772 and Rietfontein No. 3 it sends a branch lode into its hanging wall. It is from this branch that the highest platinum assays so far recorded were obtained. What is taken to be a southwesterly continuation of the main lode is exposed in the central part of Doornhoek No. 896. It is up to 30 feet in width, and at one point platinum assays up to 4 pennyweight per short ton were obtained. On the adjoining farm, Kromkloof No. 1637, there are two short stretches of lode, and on Geelhoutkloof No. 2122 there are no fewer than six lodes running roughly parallel with one another. One of them has been opened up by the New Platinums (Ltd.) and has been proved in places to carry platinum. On Zuikerboschfontein No. 1015 there are also several lodes; and at the present time the Transvaal Platinum (Ltd.) are testing a lode on Doornkom No. 1807, situated roughly 15 miles west-southwest of the camp on Rietfontein No. 3. While it has been confidently asserted that these several lodes are all on the same line of fracture, this has not been proved and does not appear at all probable.

The only section that has up to the present been shown to contain platinum ore in workable quantity is that opened up by the Transvaal Platinum (Ltd.), in the northeastern part of Rietfontein No. 3 and the adjoining portion of Welgevonden No. 1772. * * *

The lode filling varies greatly in character. In places it consists of a number of more or less closely spaced, steeply inclined quartz stringers separated by strips of felsite, sometimes of considerable width. The stringers are more or less parallel but are often connected up by diagonal and cross strings, forming a complex network. The individual stringers range in thickness from a fraction of an inch to 4 inches. They, without exception, exhibit a well-defined comb structure, being made up of slender quartz crystals arranged at right angles to their walls, from which they evidently grew inward. * * *

More commonly the lode matter is conspicuously brecciated, angular fragments of pink or red felsite and of earlier-formed quartz combs or patches of specularite or hematite lying in a matrix of later white quartz interspersed with druses and invariably exhibiting a comby or radial-fibrous texture. * * *

The mineralogy of the deposits is comparatively simple. The platinum occurs in the native state, the only other minerals present being quartz, specularite, hematite, secondary iron oxide (presumably derived from the oxidation of pyrite), a pale-green mica, a deep leek-green chromiferous chlorite, and kaolin.

The platinum is rarely visible except in specimens of the very rich ore, in which small gray or grayish-yellow metallic grains can generally be made out with the

aid of a lens. On polished surfaces of such ore the platinum shows up much better as bright white specks, the specularite with which it is often associated appearing dull and gray by comparison. The platinum grains range from 0.015 to 0.5 millimeter in diameter, but in one specimen thin crusts of the metal up to 1.3 millimeters long were observed. The grains are malleable, ductile, and fairly soft, becoming easily scratched during grinding. They are not sensibly magnetic. In microscopic and polished sections subhedral six-sided forms are sometimes observed, these being evidently oblique sections of cubical crystals. As a rule, however, the grains are irregularly rounded or of quite irregular outline, with ragged edges. * * *

The platinum is not pure but is alloyed with other metals of the platinum group. The platinum bullion contains from 20 to 40 per cent of palladium. Iridium is also sometimes present in subordinate amounts but sometimes entirely absent. Evidence of the presence of osmium has been obtained by several analysts, but that very elusive metal has not so far been definitely isolated.

BAUXITE AND ALUMINUM

By James M. Hill[1]

BAUXITE

DOMESTIC PRODUCTION, IMPORTS, AND EXPORTS

The bauxite industry of the United States showed marked improvement in 1923 over 1922, owing to the increased demand for the products made from bauxite, particularly aluminum and aluminous abrasives. The domestic production of bauxite increased 69 per cent. In the Arkansas field the increase was 85 per cent, but the eastern field was not so productive, showing a decrease of 33 per cent.

Bauxite produced in the United States, 1919–1923

Year	Georgia, Alabama, and Tennessee		Arkansas		Total	
	Long tons	Value [a]	Long tons	Value [a]	Long tons	Value [a]
1919	43,076	$346,588	333,490	$1,855,159	376,566	$2,201,747
1920	40,029	349,453	481,279	2,897,892	521,308	3,247,345
1921	14,700	134,400	124,850	755,400	139,550	889,800
1922	42,810	329,440	266,790	1,682,890	309,600	2,012,330
1923	28,810	176,030	493,880	2,980,580	522,690	3,156,610

[a] Value f. o. b. mines.

Bauxite imported into the United States and bauxite and bauxite concentrates exported from the United States, 1919–1923

Year	Imports		Exports	
	Long tons	Value	Long tons	Value
1919	6,082	$36,820	17,701	$1,372,094
1920	42,895	251,284	22,257	1,843,596
1921	27,587	164,589	5,942	488,785
1922	23,656	93,805	19,617	961,208
1923	119,020	593,882	78,560	3,380,486

Bauxite was imported from British Guiana during 1923 at the rate of 8,000 to 10,000 tons a month. Most of it was entered at Gulf ports and used in the aluminum industry. A few cargoes of South American bauxite were shipped to north Atlantic ports and consumed by the chemical industries. Undoubtedly bauxite from British and Dutch Guiana will play an important part in the future supplies of the United States. Owing to the size, quality, and ease of exploitation of the deposits in these countries, it may

[1] The figures for imports and exports in the tables in this report have been compiled by J. A. Dorsey, of the United States Geological Survey, from records of the Bureau of Foreign and Domestic Commerce.

replace all domestic bauxite except that from deposits where the conditions of exploitation are exceptionally favorable.

Some consumers of bauxite also purchased in 1923 about 14,500 tons of diaspore clay, valued at approximately $6 a ton. About 95 per cent is used in the manufacture of alumina refractories, and a small quantity in the manufacture of abrasives and chemicals.

A small quantity of alumina obtained as a by-product in the treatment of alunite for its potash content at Marysvale, Utah, was used for refractories.

The Champion Porcelain Co. uses natural andalusite mined in Inyo County, Calif., for making spark-plug porcelain.

Domestic bauxite was reported as sold to four consuming industries in 1923, as shown in the following table. The sales to the aluminum industry increased 80 per cent and those to the artificial-abrasive industry 278 per cent, but those to the manufacturers of aluminum salts decreased 12 per cent.

Domestic bauxite sold by producers to industries in the United States, 1919–1923, in long tons

Industry	1919	1920	1921	1922	1923
Aluminum	272,270	383,154	91,700	211,560	380,520
Chemical	67,842	85,878	41,000	78,540	68,870
Abrasive [a]	35,395	[b] 52,276	6,850	19,270	72,830
Refractory	1,059	([b])	----------	230	470

[a] Includes other products.
[b] Small quantity sold to makers of refractories probably included under "Abrasive."

For the last few years it has been impossible to give separate statistics showing the output of either artificial aluminum abrasives or refractories. Some measure of the combined output of these materials made from bauxite may be had from the quantity of bauxite sold to manufacturers, as indicated in the table above. Figures for aluminous abrasives heretofore reported in the chapters on bauxite and aluminum and abrasives in Mineral Resources have included annually increasing quantities of aluminum oxide used as refractory material.

Value of aluminum and aluminum salts made from bauxite, 1919–1923

Year	New aluminum	Aluminum salts
1919	$38,558,000	$8,189,500
1920	41,375,000	9,968,200
1921	10,906,000	7,547,200
1922	13,622,000	8,813,000
1923	28,305,000	8,987,400

MARKET AND PRICES

Bauxite finds its market east of Mississippi River and is sold largely to the manufacturers of aluminum, commercial chemicals, abrasives, and refractories. In the last few years some of the makers of refractories and aluminum chemicals have been using clay as a crude material in place of bauxite. The clays so used are what might be termed "high-alumina clays," in that they carry larger quantities of aluminum oxide than kaolin. Most of such clays

have come from central Missouri, where diaspore-bearing clays carrying over 50 per cent of alumina occur. These clays are now being sold according to their alumina content, and three grades containing 55, 65, and 70 per cent of alumina (Al_2O_3) are regularly handled.

The largest consumers of bauxite in the United States are also producers, and there is only a small market for what might be called "outside bauxite." Consumers who do not own deposits contract for their supplies for considerable periods, apparently to assure an adequate supply of bauxite of the grade desired. The price of bauxite at mines or shipping points in 1923, as reported by independent producers, ranged from $6.50 to $10 a ton; the average price reported by all producers for the year was $6.04 a ton f. o. b. mines. Consumers, on the other hand, report prices that average $13 a ton f. o. b. plants, a reduction of $1 a ton as compared with costs in 1922.

The price of bauxite is now regularly quoted in the Engineering and Mining Journal-Press. Crude bauxite was quoted at $6 to $9 a ton during the first half of the year and at $5.50 to $8.75 during the second half. Dried and pulverized bauxite was quoted at $12 to $14 and calcined at $22 to $25 a ton f. o. b. shipping point till July, when the price was reduced to $20 to $24. Foreign bauxite was offered at $5 to $8 c. i. f. American ports.

Under the tariff act of 1922 crude bauxite is dutiable at the rate of $1 a ton and alumina hydrate or refined bauxite at 1 cent a pound. (See par. 6, schedule 1, and par. 207, schedule 2.) Under the tariff of 1913 there was no import duty on bauxite, and the rate on alumina was 15 per cent ad valorem.

WORLD'S PRODUCTION

The following table was compiled by Miss W. I. Whiteside, of the United States Geological Survey, from official sources so far as possible.

World's production of bauxite, 1913 and 1917–1922, by countries, in metric tons

Country	1913	1917	1918	1919	1920	1921	1922
Austria:							
Dalmatia	[a]	[b] 134,781	[b] 94,500	[c]	[c]	[c]	[c]
Istria	[a]	[b] 28,341	[b] 70,100	[a]	[d]	[d]	[d]
Lower Austria	[e]	[e]	[e]	[e]	362	2,638	4,095
British Guiana		2,070	4,266	1,999	31,883	[f]	[f]
British India	1,203	1,385	1,211	1,709	6,401	6,759	4,998
France	309,294	[b] 120,883	[a]	159,103	266,716	95,318	[b] 139,176
Dutch Guiana							18,805
Germany	[g]	10,813	14,353	9,393	13,420	[a]	[a]
Hungary	1,792	[b] 128,651	[a]	[a]	[a]	[a]	[a]
Italy	6,952	7,789	7,800	2,972	[d] 13,139	[d] 49,120	[d] 65,600
Spain			460	1,780	540	184	
United Kingdom	6,152	14,960	9,743	9,369	11,197	2,305	[h]
United States	213,615	577,817	615,443	382,610	529,675	141,790	314,569
Yugoslavia	[i]	[i]	[i]	[a]	27,860	10,021	31,290

[a] Data not available.
[b] Unofficial figures.
[c] Included under Yugoslavia.
[d] Istria included under Italy.
[e] No record of any production prior to 1920, when one mine was operated.
[f] Early in 1921 operations of the bauxite mines were discontinued and the mines remained closed until late in 1922. Shipments of 20,010 tons were made from stocks in 1921. No shipments were made in 1922.
[g] Prior to 1917 no separate figures of bauxite production are available, the figures being included with those of tin, cobalt, nickel, vitriol, and bismuth.
[h] The whole of the bauxite production reported for the United Kingdom prior to 1922 was from Ireland. No statistics of Ireland's mineral production are included in the 1922 report.
[i] Prior to 1919 production included with Austria and Hungary.

BAUXITE DEPOSITS

ALABAMA

The Republic Mining & Manufacturing Co. was the only producer of bauxite in Alabama in 1923, and its operations at Rock Run, Cherokee County, were very small. During the year considerable prospecting was done in the Eufaula district, the area between Fort Gaines and Clayton, in Henry and Barbour counties, on a westward continuation of the kaolin-bauxite belt of the Coastal Plain. It is reported that there are a number of scattered deposits of bauxite of chemical grade in this area, some of which will doubtless be worked in competition with South American bauxite, as well as with the more easily accessible Georgia fields.

ARKANSAS

Five companies in Arkansas in 1923 produced 493,880 long tons of bauxite, an increase of 85 per cent as compared with the production of 1922, in spite of the "severance" tax of 25 cents a ton imposed by the State. However, as the South American aluminum-grade ores were arriving in much larger volume, and these imports will increase very rapidly, and as the American Bauxite Co. has found it necessary to begin underground mining operations,[2] the conditions do not look promising for a continuance of very large production in the Arkansas field. The underground method is to be used to mine a 160-acre tract on which the overburden is 100 feet thick. A 4,000-foot drainage and haulage tunnel has already been driven, and a retreating caving system similar to that used in mining flat coal beds will be followed. The American Bauxite Co. has recently[3] enjoined the State of Arkansas from collection of the 25-cent "severance" tax.

During 1923 two new companies entered the Arkansas field. The Southern Bauxite Co., of Benton, operated mine No. 2 at Bauxite. The Arkansas Bauxite Products Co., of Little Rock, plans the erection of a 50-ton alum plant[4] at that city, based on a supply of bauxite located near Bauxite. The Norton Co., owning bauxite deposits at Bauxite, equipped its crushing and drying plants for electrical operation.

CALIFORNIA

During 1923 the Champion Porcelain Co. operated a quarry in the Inyo Range, Inyo County, Calif., on a large deposit of andalusite,[5] an aluminum silicate carrying 63 per cent of alumina and 37 per cent of silica. The crude mineral is shipped east for use in the manufacture of spark-plug porcelain. The success of this undertaking has led to much prospecting in the northern part of the State,

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[2] Shiras, Tom, Underground mining of bauxite started in Arkansas: Eng. and Min. Jour.-Press, vol. 117, p. 497, 1924.
[3] Chem. and Met. Eng., vol. 30, p. 366, 1924.
[4] Idem, p. 213.
[5] Knopf, Adolph, An andalusite mass in the pre-Cambrian of the Inyo Range, Calif.: Washington Acad. Sci. Jour., vol. 7, pp. 549–552, 1917.

and a deposit of kyanite and sillimanite (aluminum silicate) has been discovered near Ogilby. The material from this deposit has been tested and found to contain rather too much lime for refractory use. There is a possibility, however, that by careful selective mining some ore of suitable grade can be produced.

The clay pit of the Stockton Fire Brick Co., northwest of Ione, was visited by the writer in 1923, and a bed of laterite was recognized. Analyses of red, brown, and buff laterite from this locality, furnished through the courtesy of the company, are given below.

Analyses of laterite from Ione, Amador County, Calif.

	H_2O-	H_2O+	SiO_2	Al_2O_3	Fe_2O_3
Iron laterite	(a)	(a)	29.64	27.90	24.30
Brown laterite	(a)	(a)	33.56	34.72	16.14
Light-buff laterite	1.50	12.60	38.30	41.50	6.00

[a] Not determined.

The light-buff material is slightly oolitic, resembling the bauxite kaolin always associated with the bauxite of the Eastern States. Although this occurrence does not seem to be of commercial importance, it deserves further study.

GEORGIA

Four companies produced bauxite from six counties in Georgia in 1923. The total output was 22,553 long tons, a considerable decrease from the output in 1922. The largest producer was the Republic Mining & Manufacturing Co., which operated mines near Hermitage, Floyd County, Andersonville, Sumter County, and Irwinton, Wilkinson County. The Kalbfleisch Corporation operated mines in Macon County near Andersonville and in Randolph County near Springvale. The Warner Mining Co., at Adairsville, Bartow County, and the Ideal Bauxite Mining Co., at Ellaville, Macon County, were the other producers.

The Central of Georgia Railway has recently issued a "Directory of commercial minerals in Georgia and Alabama along the Central of Georgia Railway," in which considerable information is given concerning the bauxite resources of this region.

Stull and Bole[6] have studied the possible utilization of bauxite clay, which is found in large amounts about the bauxite deposits, and conclude that these clays have considerable promise for use in the manufacture of refractory brick that would be equal or superior to fire-clay and silica fire brick.

MISSISSIPPI

No bauxite has yet been shipped from the deposits in northeastern Mississippi, which were discovered by J. W. Adams in 1921. A report on these deposits written by P. F. Morse, a geologist who examined the properties for the Mississippi Bauxite Co., has recently been printed as Bulletin 19 of the Mississippi State Geological

[6] Stull, R. T., and Bole, G. A., Refractory possibilities of some Georgia clays: Am. Ceramic Soc. Jour., vol. 6, pp. 663–673, 1923.

Survey. E. F. Burchard, of the United States Geological Survey, visited the field in June, 1923, and has supplied the following notes on this occurrence:

NEW BAUXITE FIELD IN NORTHEASTERN MISSISSIPPI

By Ernest F. Burchard

Discoveries.—In 1921 J. W. Adams, of Tuscumbia, Ala., while prospecting for clays in Alabama, discovered bauxite in that State near Margerum, Colbert County. These deposits are in erosion channels and sink holes in Mississippian limestone that have been partly filled by Cretaceous gravel. Adams believed that there should be bauxite also in adjacent portions of Mississippi, but in Tishomingo County in areas of Mississippian limestone he was able to find only deposits of ferruginous bauxitic clay. He thereupon undertook a study of the literature of the geology of Mississippi and in an early State report by Hilgard [8] found an excellent pen picture of bauxite, though Hilgard evidently did not recognize the material as such, and in fact bauxite seems not to have been known to occur in the United States until it was recognized in Georgia in 1887. Attracted by Hilgard's description Adams at once examined the deposit referred to, near Blue Mountain, Tippah County, and took samples that on analysis proved to be good bauxite. Thus encouraged and guided by the geologic relations which he had observed, Adams continued his reconnaissance and succeeded in finding deposits of bauxite or bauxitic clay in Tippah, Benton, Union, Pontotoc, Calhoun, Webster, Oktibbeha, Winston, Noxubee, and Kemper counties. Prospecting followed in the areas that were regarded as most promising, topographic maps and studies of the deposits were made by W. C. and P. F. Morse during the summer of 1922 for a syndicate of Alabama and Mississippi business men, known as the Mississippi Bauxite Co., and about 125 samples of ore and clay were analyzed by Dr. W. F. Hand at the Mississippi Agricultural and Mechanical College.

Distribution and relations of deposits.—The bauxite is distributed in groups of small separate deposits in a belt 3 to 5 miles wide describing an arc from north to southeast corresponding to the outcrop of the associated sedimentary formations. The deposits occupy the crests of hills at altitudes of 400 to 500 feet above the sea and 50 to 100 feet above local drainage levels. Their topographic position has been determined by the superior hardness of the rock bauxite, although much of the material originally present has been eroded. The formations dip to the southwest at 15 to 25 feet to the mile and do not appear to have been faulted.

Character of bauxite.—About 60 deposits, most of them bauxite, the rest bauxitic clay or bauxitic limonite, were examined by the writer accompanied by Mr. Adams. These deposits range from thin roadside outcrops to bodies proved by prospecting to be 10 to 15 feet thick and several acres in area. The bauxite is of two types—a hard, rocklike form that crops out at the tops or on the slopes of hills and a softer claylike material that lies under cover. The soft bauxite may be found under a thin cover of soil without any rock bauxite over it. The bauxite itself is similar in many respects to other American bauxites. For instance, it is typically pisolitic and grades into clay and sand containing very little aluminum hydroxide. There is, however, but little kaolin associated with it. In general the bauxite ranges from low to medium grade as compared with ores mined in Arkansas, Georgia, and France. The ferric oxide and silica in much of it are high, thus reducing the alumina proportionately. The percentage of alumina ranges from 25 to 60, but the bulk of the material carries between 35 and 45 per cent. The ferric oxide where present reaches 40 per cent but runs mainly between 5 and 35 per cent; the harder bauxite is usually the more ferruginous. Silica ranges from 3 to 40 per cent, mainly between 10 and 30 per cent, and titanium dioxide between 0.5 and 3.6 per cent. The loss on ignition ranges between 11 and 32, but mostly between 15 and 25 per cent. If the loss on ignition is considered as water and applied to the requirements of ferric oxide as limonite ($2Fe_2O_3.3H_2O$) and to that of alumina in diaspore ($Al_2O_3.H_2O$) or in gibbsite ($Al_2O_3.3H_2O$), it is found that the quantity present is higher than needed for the diaspore and slightly lower than for gibbsite. The source of the iron in the bauxite is the mineral siderite, which in fresh specimens forms a brilliantly crystalline matrix, but in most of the material the siderite is altered to limonite. Cavities were noted lined with rhombohedral crystals of siderite 2 or 3 millimeters in length, exhibiting curved

[8] Hilgard, E. W., Report on the geology and agriculture of the State of Mississippi, p. 14, Jackson, 1860.

faces. Dense, fine-grained siderite occurs in lenticular masses below and interbedded with the bauxite, and this association as well as that in the matrix is unusual for other deposits in the Coastal Plain area so far as the writer has been able to ascertain, but siderite has been found in the Arkansas bauxite.

Commercial considerations.—Estimates of the quantity of bauxite on the lands owned in fee and leased by the Mississippi Bauxite Co., made by W. C. and P. F. Morse, show a grand total of nearly 1,500,000 long tons, of which more than two-fifths carries 30 to 35 per cent of alumina (Al_2O_3), nearly as much more carries between 35 and 45 per cent, less than one-fifth carries between 45 and 55 per cent, and the remainder, which is less than 25,000 tons, is distributed between grades carrying less than 30 per cent and those containing between 55 and 60 per cent. There are other deposits of bauxite in northeastern Mississippi that have not been included in these estimates, and further studies are likely to add to the known reserves. Although the bulk of this bauxite is of low to medium grade, there are many uses for which such ore should be of value. In addition to the current metallurgical, chemical, refractory, and abrasive uses for bauxite, a new use in the manufacture of alumina cement, a quick-setting hydraulic cement now used to a large extent in France and soon to be manufactured in the United States, seems an interesting possibility.

Most of these deposits of bauxite are from 5 to 10 miles or more from the Gulf, Mobile & Northern and Mobile & Ohio railroads, and the intervening country is underlain by a tough clay, over which unsurfaced roads are impassable in wet weather and hard and rutty in dry weather. A beginning has been made in the use of gravel and concrete for road building in this part of the State, and a portion of the road from Pontotoc to Tocopola, which will tap one of the major groups of bauxite deposits, has been paved with concrete. Mining of the deposits will necessarily have to await the preparation of roads suitable for motor-truck haulage, but even though production is temporarily retarded here, the rapid depletion of ore in other domestic fields, together with the proximity of large water power at Muscle Shoals, in the adjacent portion of Alabama, encourages the belief that the bauxite of northeastern Mississippi must be considered one of the natural resources that will contribute to the utilization of the Tennessee River power.

MISSOURI

Diaspore clay amounting to 14,500 tons was produced in 1923 in central Missouri from fire-clay pits in the vicinity of Belle, Rosebud, and Owensville. Practically all of it was used in the manufacture of refractories, though a little was sold to the abrasive industry. Prices ranged from $6 to $8 a ton f. o. b. shipping point. It is reported that the deposits of diaspore in the central Missouri field are very small, and that the refractory industry will have to seek elsewhere for materials to replace this mineral in the manufacture of high-grade aluminous refractory brick.

TENNESSEE

The bauxite properties in the vicinity of Chattanooga were not particularly active in 1923. The Perry mine was operated by the Kalbfleisch Corporation, and the Branham mine, near the Perry, was under development. A little ore was shipped from the Hixon mine and it is reported that this deposit is opening up very well.

UTAH

Somewhat over 1,000 tons of by-product alumina from Marysvale was used for the manufacture of high-grade aluminous refractories in 1923. Reports [9] indicate that the Florence Mining Co. has been experimenting with a view to making a by-product alumina suitable for the manufacture of aluminum. Some experiments have also been made to determine whether aluminum sulphate and potash alum can be manufactured directly from Utah alunite.

[9] Salt Lake Min. Rev., June 30, 1923, p. 12.

ALUMINUM

DOMESTIC PRODUCTION, IMPORTS, AND EXPORTS

The value of the new aluminum produced in the United States in 1923 was more than double that in 1922, and the value of the secondary aluminum increased 78 per cent.

According to statistics collected by J. P. Dunlop, of the United States Geological Survey, secondary aluminum was recovered to the amount of 6,800 short tons as metal and 14,500 short tons as the aluminum content of casting alloys. The total recovery was 21,300 short tons.

Value of aluminum produced in the United States, imported, and exported, 1919–1923

Year	Domestic production		Imports [b]	Exports [c]
	Primary metal	Secondary metal [a]		
1919	$38,558,000	$12,014,600	$4,568,595	$3,890,326
1920	41,375,000	9,489,100	13,077,022	5,630,781
1921	10,906,000	3,775,400	8,889,791	3,108,857
1922	13,622,000	6,085,900	9,695,012	2,836,116
1923	28,305,000	10,824,600	8,742,563	3,571,539

[a] Value of secondary aluminum based on average price at New York as given by American Metal Market.
[b] Imports for consumption include aluminum in crude form, scrap, bars, strips, rods, plates, sheets, and all manufactures of aluminum.
[c] Exports include ingots, metal and alloy, plates and sheets, and all manufacture of aluminum.

The following tables show the forms in which most of our aluminum is imported and exported. In 1923 the bulk of the imported aluminum was in crude and semicrude form, and the exports were about equally divided between finished products and ingots and rolled forms.

Aluminum imported for consumption in the United States in 1922–23

Class	1922		1923	
	Pounds	Value	Pounds	Value
Crude and semicrude:				
Crude form, scrap, alloy, etc	41,730,990	$7,744,019	41,334,837	$8,028,042
Bars, strips, and rods	[a] 426,364	[a] 118,617		
Plates and sheets	[a] 992,623	[a] 269,425	299,011	96,383
Plates, sheets, strips and rods, coils, blanks	[b] 676,430	[b] 138,358		
Circles, disks, rectangles, and squares	[b] 54,285	[b] 13,308	842,941	192,391
Wire	11,241	[c] 3,092		
	43,891,933	8,286,819	42,476,789	8,316,816
Manufactures:				
Tubes, moldings, castings, and other shapes	[b] 655	[b] 525	86	214
Leaf (5½ by 5½ inches)	[d]	17,841	[d]	26,311
Powder, powdered foil	[b] 33,604	[b] 7,542	131,053	54,884
Foil less than 0.006 inch thick	[b] 2,980	[b] 1,579	15,756	14,666
Table, kitchen, and hospital utensils and other similar hollow ware	[e]	760,693	682,431	291,756
All other manufactures	[e]	620,013	58,295	37,916
		1,408,193		425,747
Grand total		9,695,012		8,742,563

[a] Jan. 1–Sept. 21, 1922, when classification was changed.
[b] Sept. 22–Dec. 31, 1922.
[c] Includes wire valued at $19, of which weight was not recorded.
[d] 1922, 30,493,800 leaves; 1923, 2,059,051,200 leaves; equivalent in pounds not recorded.
[e] Weight not recorded.

Domestic aluminum exported from the United States in 1922–23

Class	1922		1923	
	Pounds	Value	Pounds	Value
Crude and semicrude:				
Ingots, scrap, and alloys	1, 538, 079	$290, 558	1, 169, 753	$236, 878
Plates, sheets, bars, strips, and rods	2, 808, 941	836, 902	4, 369, 918	1, 280, 684
	4, 347, 020	1, 127, 460	5, 539, 671	1, 517, 562
Manufactures:				
Tubes, moldings, castings, and other shapes	353, 847	91, 086	442, 370	189, 477
Table, kitchen, and hospital utensils	1, 255, 743	692, 314	1, 175, 659	697, 372
Other manufactures of aluminum	2, 935, 359	925, 256	3, 784, 005	1, 167, 128
	4, 544, 949	1, 708, 656	5, 402, 034	2, 053, 977
Grand total	8, 891, 969	2, 836, 116	10, 941, 705	3, 571, 539

MARKET AND PRICES

Quotations on virgin aluminum, as given by the Engineering and Mining Journal-Press, were 22 to 23 cents a pound at the first of the year for the 99 per cent grade, reached 27 cents a pound in April, 26 to 27 cents in July, and 27 cents at the end of the year; the average for the year was 26.5 cents. The 98 per cent domestic grade was 1 cent a pound cheaper. Foreign aluminum was sold at 1 to 2 cents a pound below the domestic figure for similar grades, and secondary aluminum was sold at an average price of about 25 cents a pound.

ALUMINUM INDUSTRY

The demand for aluminum in 1923 was considerably increased by the great expansion of the automobile industry, coupled with the greater use of aluminum parts by the makers of automobiles. Anderson [10] estimated that exclusive of Ford cars (of which 1,500,000 were produced in 1922) the average consumption of aluminum is 100 pounds to the car. The total production of automobiles in 1922 was 2,527,000 cars, and it is estimated that 4,014,000 cars were built in 1923.[11]

The frame of the airship *Shenandoah* was built of the 17 S alloy, containing besides aluminum 4 per cent of copper and 0.5 per cent of magnesium and manganese. The new silicon-aluminum alloys containing as much as 15 per cent of silicon are also coming into more general use, particularly for casting, and nickel-silicon-aluminum and copper-silicon-aluminum alloys are being used for die casting. Aluminum powder is finding a much larger market in the paint trade and is proving a very good protective pigment for structural steel. The use of aluminum cables for transmitting high-tension electric current has been further expanded. It is stated [12] that there is in the United States 125,000 miles of aluminum cable in use for electric power transmission, of which 85,000 miles is of steel reinforced type.

Canadian aluminum plants were very much more active in 1923 than in 1922, as shown by their imports of alumina from the United

[10] Anderson, R. J., Aluminum and bauxite, 1922: Mineral Industry, vol. 31.
[11] Chem. and Met. Eng., vol. 30. p. 216, 1924
[12] Metal Industry, vol. 22, p. 3, 1924.

States and by their exports of aluminum from Canada to the United States, which increased 433 per cent as compared with 1922.[13]

French aluminum makers are reported to have been unable to supply the domestic demand,[14] yet much French aluminum was exported to the United States.

In Germany the Lautawerk, Erftwerk, and Bitterfeld aluminum plants have been producing at only about 20 per cent of their capacity,[15] owing to the poor industrial conditions. Considerable aluminum was imported into Germany from Switzerland. The annual consumption of aluminum in Germany is estimated at about 12,000 tons.

In Italy the Società italiana fabricazione allumino has been absorbed by the Società italiana di elettrochimica.[16]

Operations of the Norsk Aluminum Co., in Norway, conducted under the direction of the Aluminum Co. of America, which supplied alumina from its East St. Louis works, as well as capital for operations, were suspended early in 1924 by labor troubles.

The Swiss producer of aluminum, the Société pour l'industrie de l'aluminium à Neuhausen, apparently had a good year, as its dividend rate was raised from 9 to 12 per cent on a capitalization of 12,000,000 francs.[17]

ALUMINUM SALTS

Manufacturers of aluminum salts are believed to have consumed during 1923 about 106,900 long tons of bauxite, having an average value of $13 a ton at the plants, and an unrecorded but large quantity of high-alumina clay, as compared with 162,976 tons of bauxite and 11,428 tons of clay in 1922. These figures do not include the bauxite made into alumina as a preliminary step in the manufacture of aluminum.

Aluminum salts produced in the United States, 1922–1923

Salt	1922				1923			
	Number of producers reporting	Short tons	Value		Number of producers reporting	Short tons	Value	
			Total	Average			Total	Average
Ammonia alum	6	8,305	$535,759	$65	5	4,766	$327,017	$69
Sodium alum	3	9,506	570,372	60	(a)	(a)	(a)	(a)
Aluminum chloride	5	4,039	289,502	72	4	5,362	654,580	122
Aluminum sulphate:								
Commercial—								
General	19	231,387	6,090,166	26	15	246,095	6,354,315	26
Municipal	9	6,075	126,095	------	4	4,303	94,048	------
Iron-free	7	19,162	968,645	51	5	16,007	676,680	42
Other aluminum salts	14	3,006	232,448	------	9	13,371	880,781	------
	----------	281,480	8,812,987	------	----------	289,904	8,987,421	------

[a] Included under "Other aluminum salts."

[13] Suppl. Commerce Repts., Trade and Econ. Rev. 1922, No. 19, Canada, p. 10, 1923.
[14] Jour. du four électrique, 33d year, No. 1, p. 2, 1924.
[15] Idem, 32d year, No. 16, p. 149, 1923.
[16] Idem, 33d year, No. 2, p. 20, 1924.
[17] Idem, 33d year, No. 4, p. 51, 1924.

Aluminum salts produced in the United States, imported, and exported, 1919–1923

Year	Domestic production		Imports		Exports [a]	
	Short tons	Value	Short tons	Value	Short tons	Value
1919	223,547	$8,189,519	343	$21,877	(a)	(a)
1920	258,009	9,968,174	1,340	69,896	(a)	(a)
1921	184,813	7,547,184	1,009	45,963	(a)	(a)
1922	281,480	8,812,987	2,889	116,971	13,225	$388,447
1923	289,904	8,987,421	2,318	120,663	17,745	509,292

[a] Exports not separately shown prior to 1922. Figures for 1922 and 1923 represent aluminum sulphate only.

ALUMINOUS REFRACTORIES

High-alumina refractories are finding a wider market, and some new producers entered this field in 1923. That this industry is expanding is shown by the growing demand for high-alumina clays and other minerals by ceramists all over the country. In 1923 the makers of refractory brick took 470 tons of bauxite and 14,030 tons of high-alumina clay. Andalusite, kyanite, and sillimanite, the newly applied aluminous raw materials, were shipped from deposits in California.

At the meeting of the American Ceramic Society in February, 1924, several papers were presented concerning the possibilities of sillimanite as a refractory material, from which the following extracts are given.[18]

Hewitt Wilson's paper on sillimanite as a refractory was presented by C. E. Williams. Brick made from the crushed fused ingot of synthetic sillimanite having an $Al_2O_3 : SiO_2$ ratio of 1 : 1 failed under load below cone 18. Increasing the ratio to $3Al_2O_3 : 2SiO_2$ produced an ingot with a finer crystalline structure and with plates of corundum scattered through the mass. This material was found to bond easily with a mixture of plastic clay and alumina, and the resulting brick withstood a load of 25 pounds per square inch at cone 32 (3,100° F.; 1,700° C.).

An equilibrium diagram of the system $Al_2O_3.SiO_2$ was discussed by N. L. Bowen, and this served to explain in a measure the results of Wilson's work. The only compound present in the equilibrium diagram is the $3Al_2O_3.2SiO_2$. At 1,810° C. this breaks up into liquid and corundum—that is, it melts incongruously; there is no true melting point and consequently no eutectic. Natural sillimanite breaks up at 1,500° C. into liquid and crystals of the 3 : 2 compound. It is not surprising that the two compounds have been confused, for many of the properties are very similar, and even the refractive indices, which vary for the pure compounds, are almost identical when the 3 : 2 product contains iron or titanium.

BAUXITE ABRASIVES

During 1923 makers of artificial aluminous abrasives and aluminum oxide for other uses purchased 72,830 tons of bauxite, as compared with 19,270 tons in 1922. It is therefore evident that the industry was in much better shape than during the period 1919–22. Detailed statistics of production of aluminous artificial abrasives for recent years are not available for publication, but they are combined with the figures of output of silicon carbide abrasives in the chapter on abrasive materials.

Two recent papers by Wikoff [19] have given details concerning the use of sillimanite in the manufacture of spark-plug porcelain.

[18] Chem. and Met. Eng., vol. 30, p. 267, 1924.

[19] Wikoff, A. G., Manufacture of spark-plug porcelain: Chem. and Met. Eng., vol. 28, p. 150, 1923; vol. 29, p. 317, 1923.

The Norton Co., of Worcester, Mass., makes various refractory products of alumina fused in the electric furnace and apparently uses bauxite for some products and alumina for others.

The Vitrefrax Co., of Los Angeles, Calif., has recently put on the market several super-refractories, among which is durox, a crystalline sillimanite made in the electric furnace, and argon, a firebrick made from a highly aluminous fire clay.

BAUXITE CEMENT

The cements of high alumina content that have recently come into use in considerable quantity in France are beginning to be heard of in this country. Abroad they are called "ciment fondu," "ciment électrique," "électrice ciment," and "ciment électrico-fondu." As these names indicate, most of the material is made in the electric furnace, and the raw materials are bauxite and limestone. A discussion of alumina cements will be found in the chapter on cement in Mineral Resources of the United States for 1923.

QUICKSILVER

By Clyde P. Ross

STATISTICAL SUMMARY

Quicksilver produced in the United States in 1923

State	Mines producing	Ore treated (short tons)	Quicksilver obtained		
			Percentage tenor won [a]	Flasks of 75 pounds	Value
California	9	38,648	0.52	[b] 5,447	$357,759
Texas, Nevada, Oregon, and Idaho	5	12,148	.82	[c] 2,490	163,543
	14	50,796	.59	7,937	521,302
Total, 1922	10	43,084	.51	6,375	368,348

[a] Weighted means for 1923.
[b] Includes 31 flasks obtained from cleanups, etc., and not considered in calculating percentage tenor.
[c] Includes 179 flasks obtained from an unknown quantity of ore and not considered in calculating percentage tenor.

Average price per flask: San Francisco, $65.68; New York, $66.70; London, £10 4s. 9d.

Exports from the United States, 23,827 pounds, or 318 flasks.

Imports into the United States, 1,355,499 pounds, or 18,073 flasks.

INTRODUCTION

The condition of the quicksilver-mining industry in 1923 was somewhat better than in 1922. There was an increase of nearly 14 per cent in the average price at San Francisco and an increase of nearly 25 per cent in the production. The price of the metal declined from $70.70 a flask in the first week of 1923 to $59.35 in the last week. This drop tended to decrease production in the later part of the year. However, early in 1924 the price improved notably, and this fact may encourage a few additional operators to produce quicksilver. If, as seems quite possible, the price can be maintained at near or over $70 a flask, there will probably be a further increase in production in 1924, but it is doubtful if there will be as great a percentage increase in 1924 as there was in 1923 unless there is an unexpectedly great increase in price. The total number of known deposits of quicksilver ore in this country is not large, and most of them are so small or of so low grade that they can be operated profitably, if at all, only under unusually favorable conditions. If the new mercury boiler should prove as successful in practice as is believed by its sponsors, an increased demand for quicksilver will undoubtedly arise, but this demand is not likely to be great in the immediate future. Should it eventually become so, a large part of the quicksilver to satisfy it will have to be sought in foreign countries.

PRODUCTION

WORLD'S PRODUCTION

In the accompanying table, compiled by W. I. Whiteside, of the United States Geological Survey, are given the best figures available for the world's production of quicksilver in 1919–1923. The foreign figures, generally published in metric tons, are calculated to flasks of 75 pounds net.

Italy in 1922 and 1923 continued to be the world's largest producer of quicksilver. Her production in 1922 was nearly 44 per cent above that of 1921 but had not yet reached the amount which the deposits now in her possession showed themselves capable of yielding before the war. In 1923 there was a smaller increase in production.

The production of Spain in 1922 was more than double that of 1921 and was greater than that of any other year since 1911. In 1923, however, it showed a distinct decrease.

The output of the United States, which ranks third among the world's producers of quicksilver, increased slightly in 1922 and considerably in 1923 but is still far below the production attained in 1917.

World's production of quicksilver, 1919–1923

[1 metric ton=29.395 flasks]

Country [a]	1919		1920		1921		1922		1923	
	Flasks	Metric tons	Flasks	Metric tons	Flasks	Metric tons	Flasks	Metric tons	Flasks	Metric tons
China [b]	2,363	80.4	1,337	45.5	2,881	98.0	503	17.1	(c)	(c)
Czechoslovakia	2,352	[d] 80.0	1,958	[e] 66.6	(c)	(c)	(c)	(c)	(c)	(c)
Italy [f]	24,839	845.0	41,182	1,401.0	31,482	1,071.0	45,298	1,541.0	47,179	1,605.0
Japan [g]	18	.6	79	2.7	173	5.9	35	1.2	(c)	(c)
Mexico [h]	3,495	118.9	2,269	77.2	1,352	46.0	1,229	41.8	1,314	44.7
New Zealand [i]	149	5.1	49	1.7	21	.7	21	.7	(c)	(c)
Russia [j]	453	15.4			138	4.7	647	22.0	1,205	41.0
Spain [k]	36,055	1,226.6	25,330	861.7	18,678	635.4	38,748	1,318.2	33,646	1,144.6
United States	21,415	728.5	13,392	455.6	6,339	215.6	6,375	216.9	7,937	270.0
	91,139	3,100.5	85,596	2,912.0	61,064	2,077.3	92,856	3,158.9	91,281	3,105.3

[a] In addition to the countries shown in the table, Algeria and Chile produced in 1919 7.2 tons (212 flasks) and 2.6 tons (76 flasks), respectively. Information furnished on May 21, 1923, by the United States High Commissioner of Turkey places Turkey's average annual production at approximately 67 tons (1,969 flasks). These figures are not included in the above totals.

[b] Exports. Maritime Customs, foreign trade of China

[c] Data not available.

[d] Estimated.

[e] State Statistical Office, Czechoslovak Republic. No data of metal production are available for 1921, but 2,780 tons of ore was mined.

[f] 1919–1922, Rivista del servizio minerario; 1923, Consular report, April 3 (8), 1924.

[g] 1919–20, Agricultural and Commercial Statistics of Japan. 1921–22, Official figures furnished in Trade Commission Report, June 21, 1923.

[h] 1919–1921, Boletín Minero, Departamento de Minas, Mexico; 1922–23, Secretaría de Hacienda.

[i] Mines statement, Minister of Mines.

[j] Gornyi Zhurnal, Nos. 6–9, 1922; Nos. 10–12, 1922; Nos. 3–4, 1923; No. 2, 1924. The figures for 1923 represent the working year Oct. 1, 1922, to Sept. 30, 1923.

[k] Estadística minera de España.

DOMESTIC PRODUCTION

The number of producing mines in the United States increased from 10 in 1922 to 14 in 1923. Two of these yielded over 2,000 flasks each, and one only a little less than this. Only four others yielded more than 150 flasks each. The increase in output resulted from the

resumption of production at the New Idria mine in California. The total production in 1923 minus the 1,950 flasks yielded by this mine was 388 flasks less than the total production in 1922.

According to reports to the Geological Survey from individual mining companies or mine operators, the output of quicksilver in the United States in 1923 was 7,937 flasks of 75 pounds each, against 6,375 flasks in 1922, and 6,339 flasks in 1921.

At the average price for the year, $65.68 a flask, based on quotations for domestic quicksilver in San Francisco published weekly by the Engineering and Mining Journal-Press, the value of the output in 1923 was $521,302, an increase of $152,954 from 1922. The producers of 5,874 of the 7,937 flasks gave in their statistical reports the value of the product. On the supposition that this was in general the amount received from sales, it corresponds to an average selling price of $60.37 a flask, or $5.31 less than the average quotation in San Francisco. This doubtless results from the fact that a considerable part of the output was produced in the later part of the year, when the price was below the average for the year.

Quicksilver produced in the United States, 1920–1923, by States

State	1920		1921		1922		1923	
	Flasks	Value	Flasks	Value	Flasks	Value	Flasks	Value
California	9,849	$784,571	*3,055	$144,868	3,405	$196,741	5,447	$357,759
Oregon	24	1,912						
Texas	3,436	273,712	3,284	155,727	2,970	171,607	2,490	163,543
Nevada	83	6,612						
Idaho								
	13,392	1,066,807	6,339	300,595	6,375	368,348	7,937	521,302

A table showing the quicksilver produced in the United States from 1850 to 1921 is given in Mineral Resources for 1921.

QUANTITY AND TENOR OF ORE MINED AND TREATED

Only 53 flasks of quicksilver is reported to have been obtained from retorts in the United States in 1923, and much of this was derived from soot. The total quantity of quicksilver ore reported as treated in furnaces during the year was 50,771 tons, and this yielded 7,695 flasks of quicksilver—a rate of 0.57 per cent, or 11.4 pounds to the ton of ore. In addition an unreported quantity of material was handled which yielded 189 flasks of quicksilver. In 1922 the average yield of furnace ore was 0.48 per cent, or 9.6 pounds to the ton of ore.

METHODS OF PRODUCTION

The ores of quicksilver, unlike those of most metals that are won by smelting, are without exception in this country treated at the mines, and the liquid metal is shipped as a finished commercial product.

Methods of treatment have been briefly described in the reports for 1917, 1918, and 1919.

PRICES

The maximum average weekly price at San Francisco in 1923 was $71.50 a flask, which was reached in the weeks ending January 13 and March 24. After the latter date the price declined steadily to a minimum of $59.35 in the last two weeks of the year. By the end of the year the decrease in price had caused some operators to suspend production.

In Spain 54,813 flasks, valued at 14,609,873 pesetas, were withdrawn for sale from the Almaden stocks in 1923. At an average for the year of $0.145 per peseta, the average price of a flask was about $38.

In London the price of quicksilver in 1923 was distinctly less than in 1922.

Average yearly prices of quicksilver in the United States and the United Kingdom, 1912–1923

[Per flask of 75 pounds]

Year	San Francisco [a] (domestic)	New York [b]	London [c]			Year	San Francisco [a] (domestic)	New York [b]	London [c]		
			£	s.	d.				£	s.	d.
1912	$42.05	$42.46	8	2	10	1918	$117.50	$123.47		(e)	
1913	40.23	39.54	7	9	2	1919	90.29	92.15	20	9	5½
1914	49.05	48.31	[d] 7	15	0	1920	79.66	81.12	20	14	9
1915	85.80	87.01	14	10	8	1921	47.42	45.46	11	3	5
1916	125.89	125.49	17	2	10	1922	57.78	58.95	11	11	6
1917	105.32	106.30	22	4	3	1923	65.68	66.70	10	4	9

[a] Min. and Sci. Press, San Francisco.
[b] Eng. and Min. Jour., New York.
} Eng. and Min. Jour.-Press in 1922 and 1923.
[c] Min. Jour. (London).
[d] Metal exchange closed about three months after outbreak of war. Average based on 37 weeks only.
[e] Quoted as "nominal" only.

Although San Francisco is commonly referred to as the "primary market" for quicksilver in the United States, from the fact that the greater part of this metal produced in the country comes from the Pacific coast and goes through the hands of San Francisco firms, yet it should be noted that that city is not a market in the same sense as New York. Most of the quicksilver that passes nominally through San Francisco is handled on commission and is sold in New York, which consequently is the great distributing point of quicksilver to the actual customers. At the present low ebb in production in California the supremacy of that State as a producer of quicksilver is not so pronounced as formerly.

Prices of domestic quicksilver at San Francisco, 1921–1923, by months

[Per flask of 75 pounds]

Month	1921	1922	1923	Month	1921	1922	1923
January	$50.00	$48.50	$71.05	July	$47.75	$54.55	$66.25
February	48.75	47.65	69.20	August	47.50	56.15	65.01
March	45.88	48.65	69.53	September	47.50	63.95	61.87
April	46.00	50.85	70.26	October	46.25	70.45	61.00
May	50.00	54.40	67.16	November	40.40	70.45	61.34
June	49.50	54.75	66.80	December	49.50	70.75	59.95

IMPORTS AND EXPORTS[1]

The import duty on quicksilver under the Underwood tariff bill, enacted in 1913 and in force up to September 21, 1922, was 10 per cent ad valorem. The tariff act of 1922 placed a duty on imported quicksilver equivalent to $18.75 a flask.

In the following tables are given imports of quicksilver for domestic consumption, total annual exports, and annual exports by countries. Tables showing imports by countries for September to December, 1922, and for the year 1923 are also given. Data on imports by countries prior to September, 1922, are not available. The figures, in pounds for annual imports and exports, have been calculated to the approximate equivalent in metric tons and in flasks.

Quicksilver imported for consumption in the United States, 1918–1923

Year	Pounds	Metric tons	Flasks	Value
1918	503, 907	228. 57	6, 719	$533, 622
1919	797, 613	361. 79	10, 635	791, 226
1920	1, 062, 647	482. 01	14, 169	971, 510
1921	795, 078	360. 64	10, 601	457, 993
1922	1, 269, 004	575. 61	16, 920	757, 842
1923	1, 355, 499	614. 84	18, 073	816, 043

Quicksilver imported into the United States, September 22, 1922–December 31, 1923, by countries

[General imports]

Country	1922 (Sept. 22–Dec. 31) [a]		1923	
	Pounds	Value	Pounds	Value
North America:				
Mexico	31, 719	$15, 257	85, 868	$46, 749
Central America:				
Honduras	----------	----------	175	88
South America:				
Argentina	----------	----------	2, 700	1, 301
Chile	----------	----------	805	650
Europe:				
England	7, 500	5, 303	199, 780	125, 354
Germany	----------	----------	6, 273	4, 525
Italy	128, 900	81, 305	472, 421	273, 401
Spain	----------	----------	800, 529	448, 963
	168, 119	101, 865	1, 568, 551	901, 031

[a] Figures by countries not available prior to Sept. 22, 1922.

Quicksilver exported from the United States, 1918–1923

Year	Pounds	Metric tons	Flasks	Value
1918	232, 346	105. 39	3, 098	$338, 620
1919	683, 004	309. 80	9, 107	817, 328
1920	116, 493	52. 84	1, 553	129, 993
1921	29, 501	13. 38	393	18, 869
1922	21, 834	9. 90	291	15, 910
1923	23, 827	10. 81	318	25, 195

[1] Compiled by J. A. Dorsey, of the U. S. Geological Survey, from the records of the Bureau of Foreign and Domestic Commerce, Department of Commerce.

Quicksilver exported from the United States, 1922–1923, by countries

Country	1922		1923	
	Pounds	Value	Pounds	Value
North America:				
Canada	11,812	$8,315	13,380	$15,118
Mexico	1,335	1,061	616	653
Central America:				
British Honduras			4	6
Costa Rica	600	471	305	289
Guatemala	95	75		
Honduras	83	83	121	148
Nicaragua	1,488	1,010	376	434
Panama	76	52	421	344
Salvador	105	100	375	388
West Indies:				
British			12	17
Cuba	10	12	476	451
Dominican Republic	12	19	110	110
Haiti			175	192
Virgin Islands of the United States			15	15
South America:				
Argentina	75	60	75	91
Brazil	300	229	1,500	1,378
Chile	90	104	175	209
Colombia	2,131	1,559	2,031	1,811
Ecuador	75	75	10	13
Guiana:				
British	75	53	225	240
French	150	111		
Paraguay	10	12		
Peru	57	43	812	814
Venezuela	779	563	786	691
Europe:				
England			20	29
Sweden			55	49
Asia:				
China	50	40		
Chosen (Korea)	1,939	1,409	900	852
East Indies—Dutch			75	75
Far Eastern Republic	50	45		
India (British)	10	10		
Japan			77	108
Palestine and Syria	10	10		
Philippine Islands	317	256	620	560
Oceania: New Zealand	100	133	80	110
	21,834	15,910	23,827	25,195

USES OF QUICKSILVER

The uses of quicksilver, which are exceedingly varied, have been rather fully described in previous reports, which are still available for distribution. A process in which quicksilver vapor is employed in generating power has after years of experimentation been developed by W. L. R. Emmet, of the General Electric Co., to such a point that a unit of commercial size has been constructed at the Dutch Point plant of the Hartford Electric Light Co., Hartford, Conn. Technical descriptions of the process and of the apparatus needed will be found in publications listed in the accompanying bibliography. Essentially the process consists in vaporizing quicksilver in a boiler, using the vapor to generate power in a turbine, and then condensing the vapor by means of water, which is thereby converted into steam that may be used in an ordinary steam turbine or in other ways. The quicksilver is used repeatedly without loss. Among the advantages claimed for the process are great fuel economy and the possibility of largely increasing the capacity of power stations at a

cost materially less than that required for corresponding enlargements with steam equipment. In the plant at Hartford, which has a capacity of over 5,000 horsepower, 28,000 pounds of quicksilver is used, equivalent to about 5¼ pounds of quicksilver per horsepower if the plant is operated at full capacity. On improved future designs it is hoped to decrease the quantity of quicksilver required to about 3½ pounds per horsepower. It is estimated that about 0.8 pound of coal per kilowatt-hour is used in this plant, as compared with a consumption of about 1.4 pounds of coal per kilowatt-hour in large modern steam plants. It is necessary to use better materials and workmanship in constructing the apparatus than are required for a steam plant. All joints must be welded to prevent the escape of quicksilver.

QUICKSILVER MINING INDUSTRY BY STATES

Alaska.—So far as known, there was no quicksilver mining in Alaska in 1923.

Arizona.—Prospecting and development continued in the Phoenix and Mazatzal mountains, Ariz., but no quicksilver was produced.

California.—The production of quicksilver in California in 1923 increased 60 per cent over that of 1922. Some of the mines, however, did not produce as much in 1923 as in 1922. There were nine producers of quicksilver in California in 1923, as against six in 1922, but one of these produced only a small quantity obtained by cleaning up old condensers, and three others worked only a small part of the year and produced very little. The total production of the State was 5,447 flasks, valued at $357,759. The output in 1922 was 3,405 flasks, valued at $196,741. California produced 69 per cent of the total quicksilver output of the country in 1923, as compared with 53 per cent in 1922.

Quicksilver produced in California, 1850–1923

Year	Flasks of 75 pounds	Price per flask	Value	Year	Flasks of 75 pounds	Price per flask	Value
1850–1910	2,085,308		$93,543,501	1918	22,664	$117.50	$2,663,020
1911	18,860	$46.01	867,749	1919	15,205	90.29	1,372,859
1912	20,524	42.05	863,034	1920	9,849	79.66	784,571
1913	15,591	40.23	627,228	1921	3,055	47.42	44,868
1914	11,303	49.05	554,414	1922	3,405	57.78	196,741
1915	14,283	85.80	1,225,481	1923	5,447	65.68	357,759
1916	21,045	125.89	2,649,355				
1917	23,938	105.32	2,521,151		2,270,477		108,371,731

The event of principal importance in the quicksilver industry of California was the resumption of active operations at the New Idria mine, in San Benito County, on May 1, 1923. In Kings County, the Dawson mine was operated early in the year and yielded a small amount of quicksilver. In Lake County a small production was obtained from cleaning up old condensers. The new reduction plant at the Helen mine was destroyed by fire, but rebuilding started at once and was completed early in 1924. In Monterey County the Master Mining Co. operated early in 1923, but closed down in March, and the plant was destroyed by fire in June. In Sonoma County the

Cloverdale mine was worked at reduced capacity throughout the year, and the outlook for 1924 is reported to be good.

Idaho.—Development work was carried on in quicksilver mines in Valley County, Idaho, and a small production was made.

Nevada.—Only one operator in Nevada reported any production, and this was small. It is understood, however, that lessees obtained small amounts of quicksilver from one or two other properties.

Oregon.—The production of the Meadows district, Jackson County, Oreg., remained small in 1923 but was considerably larger than that reported in 1922.

Texas.—The Chisos mine, in the Terlingua district, Brewster County, Tex., was, as usual of late years, the one large producer in the State. Mining was hampered by trouble with water, but this difficulty has now been largely overcome. The Mariscal mine, south of McKinney Springs, in the same county, was operated until August and yielded some quicksilver.

NOTES ON FOREIGN INDUSTRY

The production of quicksilver in Spain in 1922 was much more than that in 1921, doubtless because of the improvements that have been made in plant and methods at the Almaden mine, from which most of the production comes, but in 1923 the amount produced decreased somewhat. In December, 1923, the price was fixed at 297 pesetas per flask of 34.507 kilograms, less 3½ per cent for cash in advance of delivery at the mine warehouse. Buyers of 1,000 or more flasks, paying cash in advance, are entitled to a further reduction of 6 per cent. This discount was also extended to Spanish buyers who use quicksilver in their industry, if they have paid their industrial tax and do not export the quicksilver. An additional charge of 1 peseta per flask is made for delivery on cars at Almadenejos station.

The Nikitoff mine, near Donetz, which appears to be the only producing quicksilver mine in Russia, was worked both in 1922 and 1923. In 1923 work is reported [2] to have started in June, and 17,000 tons of ore was mined. Most of this was treated, and 41 tons of quicksilver was obtained. The yield was about 0.34 per cent of quicksilver. Not more than two ovens are stated to have been in operation.

RECENT PUBLICATIONS ON QUICKSILVER

Compiled by Isabel P. Evans.

Boone, A. R., New Almaden, a century-old quicksilver mine: Eng. Min. Jour.-Press, vol. 116, No. 25, pp. 1060–1061, figs., Dec. 22, 1923. A brief history of this mine and the part it has played in the development of California.

Bürger, Otto, Kolumbien, ein Betätigungsfeld für Handel und Industrie (Quecksilber), p. 231, Leipzig, 1922. Quicksilver is found in Colombia at Quindiu, east of Cartago, around Bucaramanga and Ibaque, and in the cinnabar mines of Bermellon and El Sinabrio near Anaime. Antioquia, also, is known from its wealth of cinnabar (sulphide of quicksilver).

California State Mining Bureau, California mineral production for 1922 (quicksilver): Bull. 93, pp. 59–61, September, 1923. Summary of quicksilver activity in Santa Clara, Sonoma, Benito, and Napa counties. Table of quicksilver production in California from 1850 to 1922.

[2] Revista minera, metalúrgica y de ingeniería, Jan. 24, 1924.

Carlson, K. E., Minerals and mining (mercury): Rumania; an economic handbook, p. 119, Washington, D. C., 1924. Only mercury and sulphur have been the objects of serious attempts at exploitation in the Karpathians. There are two mercury mines at Valea-Dosului, Alba de Jos County. None of the metal, however, has been extracted since the war.

Chamber of Commerce Journal, Japanese production and imports of quicksilver: Vol. 46, No. 493, p. 23, July 13, 1923. The production of quicksilver in Japan in 1921 was more than double that of the preceding year. The increase came from the new mine, the Aibetsee, in the Ishikari district of Hokushu. As the consumption of quicksilver in Japan greatly exceeds the domestic production considerable quantities of the metal are imported.

——— Quicksilver sales in Spain: Vol. 46, No. 517, p. 330, Dec. 28, 1923.

Chemical and Metallurgical Engineering, A revolution in the power field: Vol. 29, No. 27, pp. 1174–1175, figs., Dec. 31, 1923. The rising cost of coal and its transportation makes it most desirable to reduce to a minimum the consumption of fuel for the manufacture of power. W. L. R. Emmet, the inventor of the binary vapor boiler and turbine, has succeeded in his engine in reducing cost and increasing power generation.

China Year Book, Mines and minerals (mercury), pp. 175–176, Tientsin, 1921. Of the five provinces, Kweichow, Hunan, Szechwan, Yunnan, and Kwangsi, to which mercury deposits are confined, Kweichow is the real center. Native methods are used both in mining and metallurgy. The high price of mercury during the World War stimulated production, but there has been no permanent improvement.

Chirvinskii, P. N., Sketch of the economic minerals of the Donetz coal basin (mercury): North Caucasian Meliorations, Novocherkassk. Bull. 12, pp. 193–204, 1919; Mineralog. Abstracts, vol. 2, No. 1, p. 31 (with Mineralog. Mag., Vol. 20, No. 100), March, 1923. Lists mercury among the minerals.

——— Economic minerals of southeastern European Russia (mercury): Southeastern Union of Unions of Credit and Lending Societies, Statistical-Economic Sec., Trans., pt. 3, pp. 1–84, Rostov on Don, 1919; Mineralog. Abstracts, vol. 2, No. 1, p. 31 (with Mineralog. Mag., vol. 20, No. 100), March, 1923. Mercury is included in the list of minerals from the Don region, Stavropol, Chernomorsk (Black Sea), and Astrakhan governments.

Colton, J. W., Mercury vapor turbine: Aera, vol. 12, pp. 916–920, il., Albany and New York, January, 1924. New invention put in practical service greatly increases fuel efficiency and ultimately may lead to a revolution in boiler-house practice in electric generating stations.

Cropp, W. H., Some essentials in the economic development of a cinnabar deposit: Chem. Eng. and Min. Rev., vol. 15, pp. 347–352, Melbourne, July 5, 1923. Gives the foundations of the quicksilver industry, based on the small stable world demand; the present state of the industry; and the markets available to Puhipuhi, New Zealand, and Australia.

Dominian, Leon (American consul, Rome, Italy), The Banca Commerciale and Italian mercury production, June 18, 1923 (U. S. Geol. Survey cons. file, No. 5934). The Italian production in 1922 amounted to 1,541 tons of metallic mercury, one-half of which was obtained from Tuscany, the rest from the district of Trieste. In 1921 the total production was 1,071 tons. The largest producer of mercury is the Monte Amiata Mining Co.

Dutch East Indies (cinnabar): Jaarb. v. h. Mijnwesen, 48th year, 1919, pp. 463–465, 1922. Cinnabar has been found in Sumatra in River Gloegoer, branch of River Melipoen, and in River Salak. In the latter place it occurs with gold. The quantity of cinnabar is very small.

Eakle, A. S., Minerals of California (cinnabar): California State Min. Bur. Bull. 91, pp. 43–46, 1923. In California the most valuable cinnabar deposits lie in the Coast Range from Del Norte County to San Diego County; those in the Sierra are of minor value.

Electrical Review (London), The Emmet mercury boiler: Vol. 93, pp. 993–994, Dec. 28, 1923. A great step forward is represented in the installation of a mercury boiler and turbine at the Dutch Point station of the Hartford Electric Light Co. Mr. Emmet, the inventor, claims the mercury-steam combination should give about 52 per cent greater output of electricity for equivalent fuel consumption.

Electrical World, First mercury boiler is now installed: Vol. 81, No. 23, p. 1369, June 9, 1923. Describes in detail the new mercury boiler to be used by the Hartford Electric Light Co. at its Dutch Point plant. This installation has attracted much interest because of its novel character. Approximately 15 tons of mercury was used in the installation.

EMMET, W. L. R., Emmet mercury-vapor process: Mech. Eng., vol. 46, pp. 235–240, 305, il., diagrs., May, 1924. Describes his early experiments, the possibilities of the process, the Hartford installation, the boiler problems, the attainable economies, and the future of the mercury supply.

ENGINEER, Mercury-vapour prime mover: Vol. 136, pp. 561–562, Nov. 23, 1923. The advantage in using two fluids instead of one arises from the fact that by adopting the binary-fluid principle the working range can be split into a high and a low part, for each of which a separate fluid may be adopted.

ENGINEERING AND MINING JOURNAL-PRESS, Quicksilver claims will be developed: Vol. 115, No. 22, p. 995, June 2, 1923. The Porterie Mercury Mining Co. has been organized to develop the cinnabar in the Winifred mining district, about 10 miles northeast of Phoenix, Ariz.

———, Terlingua, Texas, produced 40 per cent of country's mercury in 1922: Vol. 115, No. 24, p. 1080, June 16, 1923. Discovery of coal in the Terlingua district has caused extensive prospecting, which has established the fact that there are outcrops of rich cinnabar ore running 30 miles east and west from Terlingua and having a width of about 20 miles.

——— The Emmet mercury boiler: Vol. 116, No. 25, p. 1057, Dec. 22, 1923. It is stated that the use of quicksilver in place of water in a boiler, if adopted to any extent, will greatly increase the production and price of quicksilver.

——— New Idria Quicksilver Mining Co. will expand output: Vol. 117, No. 5, p. 219, Feb. 2, 1924. This company is now operating at Idria one rotary furnace and expects to put in another furnace within a month. At present 80 tons of ore is mined daily, and underground development is under way. This company is now the largest quicksilver producer in the United States.

——— Attractive possibilities of mining in Turkey (mercury): Vol. 117, No. 8, p. 328, Feb. 23, 1924. Mercury has been extracted in an experimental manner at Ushak, Province of Smyrna.

EVANS, U. R., Metals and metallic compounds (mercury): Vol. 4, pp. 171–193, New York, 1923. Describes the metal, its metallurgy and uses, and names the countries in which it occurs—Almaden (Spain), Idria, Tuscany, California, Texas, and Mexico.

GOULD, H. W., Quicksilver: Eng. and Min. Jour.-Press, vol. 115, p. 100, Jan. 20, 1923. The most important change made during 1922, which will influence the marketing of quicksilver, was the passage of the McCumber-Fordney tariff bill in October, which imposed a tariff of 25 cents a pound, or $18.75 a flask.

——— Quicksilver: Eng. and Min. Jour.-Press, vol. 117, No. 3, p. 95, Jan. 19, 1924. Production in the United States and in Europe showed improvement in 1923. The most hopeful development was the heavy consumption of over 32,000 flasks. The year 1924 will show considerable increase in domestic production because of increased consumption and the prospect of new uses.

GREAT BRITAIN, IMPERIAL MINERAL RESOURCES BUREAU, The mineral industry of the British Empire and foreign countries, Quicksilver, 15 pp., 1923. Gives statistics of world production, 1919–1921, summary and details of exports and imports, prices, and list of statistical publications.

HALSE, EDWARD, Mercury ores: Great Britain, Imp. Inst., Mon. Mineral Resources, pp. 1–101, map, 1923. Gives the occurrence, characters, uses, and sources of supply of mercury ores. Bibliography, pp. 93–101.

HAMILTON, A., Mercurialism in quicksilver production in California: Jour. Ind. Hygiene, vol. 5, pp. 399–407, March, 1924. Describes the effect of mercurialism as observed in the California quicksilver mines. If a man takes a shower bath, rinses his mouth, and puts on fresh clothing at end of his shift, he can protect himself against an attack. Old hands who have learned prudential methods can keep on for years in the mines.

HENDERSON, J., Cinnabar in Greenvale survey district, near Waikaka, Southland: New Zealand Geol. Survey, new ser., Seventeenth Ann. Rept., p. 12, 1923. Three veinlets of cinnabar, in a zone 10 to 12 feet thick, have been exposed on top of a rounded hill in sec. 8, block 11, Greenvale survey district. A general sample was found by the Dominion analyst to contain 0.88 per cent of mercury.

——— A sketch of the economic development of New Zealand (quicksilver): New Zealand Jour. Sci. Tech., vol. 6, No. 1, pp. 2, 8, May, 1923. Mining quicksilver has not been profitable at Ohaeawai and Karangahake but is still being carried on at North Auckland. The deposits of mercury ore in North Auckland are large enough to place the production of the metal on a commercial basis.

HENDERSON, J., Notes on the geology of the Nevis Valley, Otago (cinnabar): New Zealand Jour. Sci. Tech., vol. 6, No. 2, p. 127, August, 1923. Fragmental cinnabar is associated with all the alluvial gold of the Nevis Valley, small in amount in the lower basin and in a fine state of subdivision. It is coarser in the upper basin and increases in coarseness and quantity at the head of the river.

IDAHO, INSPECTOR OF MINES, Mining industry of Idaho (quicksilver): Twenty-fifth Ann. Rept., pp. 33, 54, 90, 97, 198, 208, 1924. Quicksilver has been found in Blaine, Custer, and Elmore counties. The principal mercury mining companies are the Fern Quicksilver Mining Co. and the United Mercury Mines Co., of Valley County.

KEARTON, W. J., Possibilities of mercury as a working substance for binary-fluid turbines: Engineering, London, vol. 116, pp. 663–667, 696–697, Nov. 23, 30, 1923. Discussion, pp. 640–645, Nov. 23, 1923. Tabulates data as to the properties of mercury vapor throughout a great range of pressures and temperatures. The discussion considers the practicability and possible economic value of the mercury-steam turbine.

LINCOLN, F. C , Mining districts and mineral resources of Nevada (mercury), pp. 278–279, Reno, 1923. From 1903 to 1920 Nevada produced 14,227 flasks of mercury. Gives producing districts and localities for mercury deposits that may prove of economic value in the future. Cinnabar is present in precious-metal veins of the State and is associated with some sulphur deposits.

MECHANICAL ENGINEERING, The mercury-vapor boiler and turbine: Vol. 46, No. 2, pp. 91–93, 3 figs., February, 1924. A very clear description of this engine, which will utilize commercially two fluids in a heat engine and thus increase the thermal economy.

——— The binary cycles using mercury and steam: Vol. 46, No. 3, pp. 142–144, 3 figs., March, 1924. Gives technical reasons to show that the Emmet mercury-vapor-steam turbine engine is economical.

METALLGESELLSCHAFT, Frankfurt am Main, Statistische Zusammenstellungen über Aluminium, Blei, Kupfer, Nickel, Quecksilber, Silber, Zink und Zinn: Jahrg. 24, 1913–1922, p. 11, September, 1923. Gives the production of quicksilver from 1913 to 1922 in Spain, Italy, Austria-Hungary, California, Texas, and Mexico.

MINING JOURNAL (London), Quicksilver find in Japan: Vol. 140, p. 111, Feb. 10, 1923. A rich discovery of mercury is reported from Kita-uome-mura, Minimimat-suura-gun, in Nagasaki Prefecture. Drops of metallic mercury were noticed in pools after rain. The seam is reported to be 7 miles long, and the assays give a return of 18 per cent and rarely as much as 30 per cent of mercury.

——— (mercury): Vol. 144, p. 131, Feb. 16, 1924. Mercury is reported in Turkey from Ushak, Province of Smyrna, and from the Vilayet of Brusa.

MUSET, M., Les gisements métallifères et l'industrie métallurgique en Yougoslavie (mercure): Rev. ind. min., No. 57, p. 166, Paris, May 1, 1923. The old mines at Avala, Yugoslavia, containing mercury accompanied by barite and pyrite, which had been closed for lack of capital, have been reopened. In Bosnia, at Nratchaï, the ore contains 10 to 12 per cent of mercury, and at Machocov 7 to 8 per cent, but there is no production at either place.

PENZER, N. M., The mineral resources of Burma (mercury), p. 120, London, 1923. Cinnabar has been reported in the Shan States, but it is considered probable that the brilliant red clay derived from the dolomitic limestones of the plateau has been mistaken for this mineral.

PIROGOV, L., Mercury works and mines of Nikitovka: Gornyi Zhurnal, year 98, Nos. 10–12, pp. 413–415, Moscow, October–December, 1922 [text in Russian]. Gives table of annual and monthly production of quicksilver ore from these mines from 1913 to 1921 and annual production of distilled quicksilver from 1915 to 1921. Also estimates their distilled quicksilver production from October, 1921, to September, 1922.

POLEVOI, P. I., Useful minerals of the Russian Far East (quicksilver): Geol. Comm. Russian Far East, No. 27, p. 268, 1923. Cinnabar is reported in Transbaikalia, not far from Nertchinsk, on a tributary of the Argun which flows into Amur River, and near Chita, very near Khilak River.

POWER, The Emmet mercury boiler: Vol. 58. No. 23, pp. 876–880, figs., Dec. 4, 1923. "In general design the mercury turbine is not unlike a steam turbine except that the blading is of tool steel to resist the cutting action of the mercury, and the glands are sealed with illuminating gas."

Rastall, R. H., The geology of the metalliferous deposits (mercury), pp. 396–403, Cambridge, 1923. Describes the geology of the mercury deposits of Almaden, Idria, Tuscany, and the Pacific slope. Names the location of the principal deposits in each country.

Raw Materials Review, Minerals and metals—quicksilver: Vol. 2, No. 12, p. 174, April, 1923. Recently a rich quicksilver vein has been discovered in Japan, near the village of Kitauonome, in the Upper Goto Archipelago, which is said to extend more than 7 miles on the surface and to range in width from 2 to 6 feet. Assays show the ore to contain about 18 per cent of quicksilver.

Rickard, T. A., The tellurides (mercury): Eng. and Min. Jour.-Press, vol. 114, No. 23, p. 973, Dec. 2, 1922. The telluride of mercury is named coloradoite because it was first found in Boulder County, Colo. The detection of mercuric tellurides is easy, because when heated they give a fume that readily condenses into globules of quicksilver.

Roberts, William, A reconnaissance in Turkestan and southern Siberia (quicksilver): Min. Mag., vol. 30, No. 6, p. 332, London, June, 1924. Many evidences of cinnabar and globules of quicksilver were observed in the Achar Mountains and near the Pamur Plateau.

Salt Lake Mining Review [Mercury Mining Co. again working quicksilver mines at Ione, Nev.]: Vol. 25, No. 5, p. 25, June 15, 1923. New deposits of high-grade cinnabar have been found at Ione, and interest in the properties has been stimulated by the higher price of quicksilver.

Scientific American, Power from mercury vapor: Vol. 130, pp. 80–83, 5 figs., February, 1924. Very thorough, illustrated account of the new Emmet mercury vapor and steam plant, which is showing an astonishing fuel economy through a combination of mercury vapor and steam.

Spurr, J. E., The origin of metallic concentrations by magmation (mercury): Econ. Geology, vol. 18, No. 7, pp. 635–636, October–November, 1923. A theory of the origin of mercury ores.

Svetolik, S., Crystallographic and optical study of the cinnabar of Avala: Soc. franç. min. Bull., vol. 45, No. 8, pp. 134–161, December, 1922. Forty-five cinnabar crystals from the mercury mine, Suplja Stena, on the Avala Mountain, near Belgrade, Serbia, are figured.

Tegengren, F. R., The Hsi-K'uang-Shan antimony mining fields, Hsin-Hua district, Hunan: China Geol. Survey Bull. 3, p. 9, October, 1921. There is an intimate connection between stibnite (or antimony) and cinnabar deposits, the former mineral occurring at the Wan-Shan-Ch'ang and Ta-Tung-La quicksilver mines, and, on the other hand, cinnabar has been found at Hsi-K'uang-Shan.

Treat, A. W. (American consul, Smyrna, Turkey), Quicksilver industry—Asia Minor, May 21, 1923 (U. S. Geol. Survey cons. file No. 5859). At present there is only one mercury mine in Turkey, which is the property of the Karabournou Mercury Syndicate. The largest deposit of mercury in Asia Minor appears to be at Karabournou; the principal output has been sent to British and American markets. Prospecting has been carried on at Thyra and Odemish with but little success.

Van der Veen, R. W., The Almaden mercury ores and their connection with igneous rocks: Econ. Geology, vol. 19, No. 2, pp. 147–156, figs., March, 1924. States that in the neighborhood of Gargantiel, Spain, are quicksilver deposits, already worked out.

SILVER, COPPER, LEAD, AND ZINC IN THE CENTRAL STATES[1]

(MINES REPORT)

By J. P. Dunlop and F. Begeman

INTRODUCTION

The silver, copper, lead, and zinc mines of the Central States are in Arkansas, Illinois, Kansas, Kentucky, Michigan, Missouri, Oklahoma, and Wisconsin. The territory thus embraced lies in the great interior valley province of the United States, which extends from Appalachian system to the Rocky Mountain front, exclusive of the Black Hills. Most of the mines are in the Paleozoic sedimentary rocks of this province, but the copper range of northern Michigan comprises lavas and intercalated sediments of pre-Cambrian age.

In the lead and zinc regions of the Central States the material sold is principally concentrates,[2] and payment is made according to a basic price for concentrates of a certain quality. The details of this method are given in the pages devoted to Missouri in this report for 1914. The figures reported to the Geological Survey by producers represent the quantity and assay contents of concentrates sold and the amount received in payment. The total metal produced is calculated from the first two of these items.

The operators in Michigan report the quantity of concentrates produced and the actual recovery of copper from concentrates smelted.

In any year the mines may produce more or less concentrates than are smelted during the same period. The copper content of concentrates produced but not smelted during the year has been estimated on the basis of the average copper recovery per ton for the year of the company producing it.

TENOR OF LEAD AND ZINC ORES OF THE CENTRAL STATES

Much of the ore mined in the Western States is crude smelting ore—that is, it can be smelted directly without preliminary concentration. All but a very small portion of the ore from the Central States, however, is of such tenor that it requires concentration. The only fair basis for comparison of the relative magnitude of mining operations in different States is that of quantity of crude ore, or "dirt." In Kentucky and southern Illinois the lead and zinc con-

[1] A bibliography is given in Mineral Resources for 1919 and some preceding volumes.

[2] In local usage the ore as mined is called "dirt" and the concentrates are classed as "ore." Where the capacity of a concentrating plant is given, such capacity is to be understood as based on a 10-hour shift unless otherwise stated.

centrates are recovered as by-products in the concentration of the fluorspar which they accompany, and it was not possible to make calculations of the metal content of the crude ore raised.

Quantity and tenor of copper, lead, and zinc ores of Central States, 1921–1923

State	1921		1922		1923	
	Crude ore	Metal content [a]	Crude ore	Metal content [a]	Crude ore	Metal content [a]
	Short tons	*Per cent*	*Short tons*	*Per cent*	*Short tons*	*Per cent*
Arkansas	(b)		(b)		(b)	
Illinois (northern)	81,400	4.10	66,150	6.71	86,100	2.10
Kansas	1,132,000	5.26	2,151,200	4.00	2,680,700	4.26
Michigan	3,610,648	1.19	4,952,264	1.23	5,363,160	1.29
Missouri	5,302,100	3.69	5,879,700	3.40	6,098,900	3.16
Oklahoma	2,969,500	5.97	6,159,500	4.82	7,937,200	4.20
Wisconsin	136,300	3.78	221,000	3.90	454,000	3.34
	13,231,948		19,429,814		22,620,060	

[a] The percentages given in this column represent the metal content of the ore in so far as it is recovered in the concentrates. In Michigan the metal so recovered is copper, in the other Central States the metals are lead and zinc, the relative proportions of which are shown in the table on another page and in the tables of tenor of ore given in the sections devoted to the respective States.

[b] No record of ore treated.

The marked increase in 1923 shown by this table was distributed mainly among the copper mines of Michigan and the lead and zinc mines of Oklahoma and Kansas. Smaller increases in output of lead and zinc ores occurred in Wisconsin, Missouri, and Illinois. The output of disseminated lead ore in southeastern Missouri increased 162,500 tons.

The low average tenor of the crude ore mined in the Central States in 1923 is best shown by the fact that the average value of the total metal content was only $4.76 a ton of crude ore treated, though this was 63 cents more than in 1922, owing to the higher price of copper, lead, and zinc. The 17,256,900 tons of zinc, lead, and lead-zinc ores treated in the Central States exclusive of southern Illinois, Kentucky, and Arkansas in 1923 yielded lead and zinc concentrates that sold for $58,989,083, so that the mine operators realized an average of $3.42 a ton of ore mined and treated, against $2.90 a ton in 1922. The value of both lead and zinc concentrates was greater in 1923 than in 1922. The quantity of zinc concentrates increased greatly; the quantity of lead concentrates decreased about 12,600 tons.

PRODUCTION

GENERAL STATISTICS

The total value of the mine production of silver, copper, lead, and zinc in the Central States in 1923 was $27,545,035 more than the value for 1922. The total value for the years 1907 to 1923, was $1,609,909,432—$588,746,272 for copper, $598,758,694 for zinc, $415,933,032 for lead, and $6,471,434 for silver. The value of the zinc has been much greater than that of the copper for the last five years, so that the total value of the zinc produced during the period is over $10,000,000 more than that of copper.

Mine production of silver, copper, lead, and zinc in the Central States in 1923, by States

State	Silver		Copper	
	Fine ounces	Value	Pounds	Value
Illinois	8,170	$6,699		
Michigan	223,997	183,678	138,304,080	$20,330,700
Missouri	177,270	145,361	202,556	29,776
	409,437	335,738	138,506,636	20,360,476
Total, 1922	595,671	595,671	122,509,765	16,538,818

State	Lead		Zinc		Total value
	Short tons	Value	Short tons	Value	
Arkansas	25	$3,500	148	$20,128	$23,628
Illinois	1,381	193,340	1,266	172,176	372,215
Kansas	17,598	2,463,720	100,969	13,731,784	16,195,504
Kentucky	53	7,420	270	36,720	44,140
Michigan					20,514,378
Missouri	169,743	23,764,020	18,265	2,484,040	26,423,197
Oklahoma	66,904	9,366,560	242,421	32,969,256	42,335,816
Wisconsin	734	102,760	13,211	1,796,696	1,899,456
	256,438	35,901,320	376,550	51,210,800	107,808,334
Total, 1922	266,689	29,335,790	296,430	33,793,020	80,263,299

Silver.—Nearly all the silver that has been produced in the Central States has been recovered incidentally in the production of other metals. The output in 1923 from the copper lodes of Michigan showed a decrease of 152,993 ounces, and that from the refining of lead bullion from Missouri decreased 35,386 ounces. The lead-zinc fluorspar deposits of the Kentucky-Illinois field also carry silver, and the silver recovered from the lead concentrates from Illinois was 8,170 ounces, an increase of 2,145 ounces.

Copper.—The mine production of copper in the Central States in 1923 came from Michigan and Missouri. Michigan, which, as in other years, contributed nearly the whole of the output, produced 16,591,715 pounds more than in 1922. The copper produced in Missouri was derived entirely from lead ores. The total mine production of copper from Michigan and Missouri in 1923 was about 136,000,000 pounds less than in 1916.

Lead.—The mine production of lead in the Central States in 1923 showed a decrease of 4 per cent. Missouri produced 66 per cent of the yield, against 67 per cent in 1922, and the recoverable lead content of galena and lead carbonate concentrates mined in Missouri equaled 31.2 per cent of the refined primary lead recovered in the United States from domestic ore. Of the total output of lead in Missouri the disseminated-lead district of southeastern Missouri produced 167,346 tons, again exceeding the Coeur d'Alene district of Idaho and retaining first place in the production of lead in the United States. Small shallow lead mines and barytes mines in southeastern Missouri reported the recovery of 112 tons of lead. Southwestern Missouri had an output of 2,285 tons, or 641 tons more than in 1922. The production in Oklahoma increased from 62,856 tons in 1922 to

66,904 tons in 1923. The production from Kansas mines decreased from 23,271 tons in 1922 to 17,598 tons in 1923; Illinois increased from 1,325 to 1,381 tons, and Wisconsin increased from 691 to 734 tons. The total production of lead from mines in the southern Illinois-Kentucky region, Arkansas, and the upper Mississippi Valley amounted to less than 1 per cent of the output of the Central States.

Zinc.—The figures showing production of zinc in the Central States in 1923 are based on mine returns, with a deduction for separating and smelting losses. The production of zinc in the Central States was about 74 per cent of the total output of primary zinc from domestic ores in the United States, against 84 per cent in 1922. Oklahoma produced 224,156 tons more zinc than Missouri. For many years, until 1917, Missouri had been the largest producer of zinc in the United States, but the output has decreased from 132,918 tons in 1917 to 18,265 tons in 1923. The production of zinc in Kansas rose from 36,994 tons in 1921 to 56,225 tons in 1922 and to 100,969 tons in 1923. Arkansas increased in output from 134 to 148 tons; Kentucky increased from 142 to 270 tons; Illinois decreased from 3,124 to 1,266 tons. No production of lead or zinc was reported from Iowa mines in 1923.

PRODUCTION OF LEAD AND ZINC, BY REGIONS

The productive lead and zinc territory in the Central States naturally falls into seven regions, three of which are not limited to a single State. For statistical purposes the tables showing the production of lead and zinc by States are necessary, but for practical purposes it is desirable to show the production by the natural regions irrespective of State lines.

The seven regions, are in order of size of output, (1) the Joplin region, comprising southwestern Missouri, southeastern Kansas, and northeastern Oklahoma; (2) southeastern Missouri, containing the great deposits of disseminated lead; (3) the upper Mississippi Valley region, including all the lead and zinc mines in southwestern Wisconsin, Iowa, and northwestern Illinois; (4) the fluorspar region in southern Illinois and northern Kentucky; (5) northern Arkansas; (6) central Missouri; (7) the Arbuckle Mountain region, in southern Oklahoma.

The southeastern Missouri region produced 65.3 per cent of the lead output of the Central States and 30.8 per cent of the primary lead recovered from domestic ore smelted or refined in the United States in 1923. The Joplin region alone produced 33.8 per cent of the lead and 96 per cent of the zinc of the Central States in 1923 and was much the largest producer of zinc in the United States, yielding 71 per cent of the total zinc produced from domestic ores, as against 80 per cent in 1922.

The lower zinc content of the zinc concentrates produced at mines in the upper Mississippi Valley region is clearly indicated by the fact that, although these mines yielded more than 7 per cent of the total output of raw zinc concentrates of all classes, the zinc content of such concentrates was only 3.8 per cent of the zinc from mines in the Central States.

The lead content of the galena concentrates shipped from the upper Mississippi Valley region averaged 75.2 per cent, that of the

concentrates from the Joplin region averaged between 79 and 80 per cent, and that of the concentrates from the southeastern Missouri region averaged 65.9 per cent. A very small proportion of the galena shipped from the Joplin region contained more than 82 per cent. A large part of the sphalerite shipped from the Joplin region contained about 60 per cent of zinc, and the 47,030 tons shipped from the Waco district in that region averaged 61.2 per cent.

Mine production of lead and zinc in the Central States in 1923, by regions

Region	Lead [a]		Zinc [b]		Total value
	Short tons	Value	Short tons	Value	
Concentrates:					
Joplin	111,209	$10,561,445	689,528	$27,898,393	$38,459,838
Southeastern Missouri [c]	259,320	19,434,633			19,434,633
Upper Mississippi Valley [d]	1,285	104,629	53,789	989,983	1,094,612
Kentucky-southern Illinois	1,840	139,508	940	20,387	159,895
Northern Arkansas	32	2,559	444	9,919	12,478
	373,686	30,242,774	744,701	28,918,682	59,161,456
Total, 1922	385,715	23,424,752	573,966	18,632,690	42,057,442
Metal:					
Joplin	86,787	12,150,180	361,655	49,185,080	61,335,260
Southeastern Missouri [c]	167,458	23,444,120			23,444,120
Upper Mississippi Valley [d]	948	132,720	14,429	1,962,344	2,095,064
Kentucky-southern Illinois	1,220	170,800	318	43,248	214,048
Northern Arkansas	25	3,500	148	20,128	23,628
	256,438	35,901,320	376,550	51,210,860	87,112,120
Total, 1922	266,689	29,335,790	296,430	33,793,020	63,128,810

[a] Includes both galena and a small quantity of lead carbonate concentrates.
[b] Includes sphalerite, zinc carbonate, and zinc silicate concentrates.
[c] Includes a small production from the central Missouri region.
[d] Includes Iowa, northern Illinois, and Wisconsin.

Mineral Resources for 1914 contains brief reviews of the history of lead and zinc mining in the Central States, the yearly production of each State for the period 1907 to 1914, inclusive, and historical notes and estimates of the total production of lead and zinc in each State before 1907.

ARKANSAS

The value of the lead and zinc from Arkansas mines, which was $1,430,668 in 1917, was only $23,628 in 1923. The decrease in shipments was caused almost entirely by the low price of zinc carbonate concentrates, which offered little encouragement to owners of old mines and did not invite the investment of new capital.

The production of galena in Arkansas is small compared with that in other regions. The shipments of zinc carbonate and zinc silicate concentrates, 444 tons, were less than 3 per cent of the shipments in 1917.

Mine production of lead and zinc in Arkansas, 1907–1923 [a]

Year	Lead concentrates (galena)		Zinc concentrates				Metal content			
			Sphalerite		Silicate and carbonate		Lead		Zinc	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1907–1915	416	$22,348	8,576	$315,910	12,221	$506,842	331	$29,394	8,290	$1,365,538
1916	339	28,097	1,670	112,726	16,609	940,224	272	37,536	6,815	1,826,420
1917	474	47,593	916	57,824	17,053	650,585	382	65,704	6,691	1,364,964
1918	155	13,594	310	16,450	2,156	68,333	120	17,040	951	173,082
1919	35	2,400			510	18,170	28	2,968	189	27,594
1920	10	755			917	28,925	8	1,280	329	53,298
1921	27	1,510			42	580	21	1,890	15	1,500
1922	55	4,000			425	6,870	42	4,620	134	15,276
1923	32	2,559			444	9,919	25	3,500	148	20,128

[a] In calculating the metal content of the ores from assays allowance has been made for smelting losses of both lead and zinc in 1921, 1922, and 1923. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, whereas the value of the lead and zinc is calculated from the average price of all grades.

Tenor of lead and zinc ore and concentrates produced in Arkansas in 1920–1923

	1920	1921	1922	1923
Total crude ore, short tons	9,800			
Total concentrates in crude ore:				
Lead, per cent	0.11			
Zinc, do	9.36	(a)	(a)	(a)
Metal content of crude ore:				
Lead, do	.08			
Zinc, do	3.73			
Average lead content of galena concentrates, do	80.0	77.7	78.2	78.1
Average zinc content of zinc silicate and carbonate, do	39.9	40.0	36.0	37.8
Average value per ton:				
Galena concentrates	$75.50	$55.93	$72.73	$79.97
Zinc silicate and carbonate	$31.54	$13.81	$16.16	$22.34

[a] The quantity of ore mined was very small, and very little of it was milled, so that no calculations as to tenor are available; part of the ore sold was taken from stock in bins.

The mines are principally in Boone and Marion counties and the adjoining portions of Searcy and Newton counties, though there are numerous prospects in Baxter, Izard, Sharp, Lawrence, and other counties to the east, and deposits have been worked in Washington and Sevier counties, on the extreme western border of the State.

The ores are galena, sphalerite, and smithsonite, and the concentrates produced are generally of high grade and free or nearly free from iron or lime. The sphalerite and smithsonite are shown by analysis to contain appreciable quantities of cadmium, especially in a yellow variety of smithsonite known locally as "turkey fat," which shows as much as 0.8 per cent of cadmium.

Few of the lead and zinc mines in Arkansas were operated in 1922 and 1923, and none of those from which concentrates were shipped were operated steadily. The shipments of lead and zinc ores made in 1923 came from six small mines, and the value of the concentrates shipped increased from $10,870 in 1922 to $12,478 in 1923.

The Ozark mine, near Flippin, in Marion County; the Loney Boy mine, at Rush, in Marion County; and the lessees of the American Zinc, Lead & Smelting Co.'s land in Newton County produced all the

zinc concentrates shipped in 1923, and mines on the Brewer land at Ponca, in Newton County, produced most of the galena concentrates.

Most of the zinc carbonate ore shipped in 1923 was mined and milled in 1921.

Only development work was done at the J. E. Nischwitz prospect, near Flippin, Marion County, and no ore was sold.

The Ozark Mining Co. has a 250-foot tunnel and a 150-ton mill equipped with jigs and 10 tables. Considerable development work was done and about 1,000 tons of ore was milled, though little of the concentrate was sold in 1923.

The only shipment of lead concentrates from Marion County in 1923 was made by B. Lawhorn.

The Loney Boy mine, at Rush, was leased by John C. Dirst, and several cars of zinc carbonate concentrates were shipped. Oil engines and an air compressor were installed and other improvements made.

The Ohio mine, near Flippin, in Marion County, is equipped with a 125-ton mill. A new compressor and some tables were added to the plant in 1923, and several cars of zinc carbonate were shipped.

Nearly all the concentrates shipped from Newton County in 1923 were taken from stock piles of lessees of the American Zinc, Lead & Smelting Co., the Confederate Mining Co., and Hawkins & Baker.

ILLINOIS

By J. P. Dunlop

PRODUCTION

Mine production of lead and zinc in Illinois in 1923, by districts [a]

District	Lead concentrates (galena)		Zinc concentrates (sphalerite)		Metal content [b]			
					Lead		Zinc	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Northern Illinois	307	$23,806	4,773	$75,278	214	$29,960	1,218	$165,648
Southern Illinois	1,762	133,356	90	2,462	1,167	163,380	48	6,528
Total, 1922	2,069	157,162	4,863	77,740	1,381	193,340	1,266	172,176
	1,880	126,953	9,500	189,825	1,325	145,750	3,124	356,136

[a] Mineral Resources for 1914 contains a historical review of lead and zinc mining in Illinois.

[b] In calculating the metal content of the ores from assays allowance has been made for smelting losses of both lead and zinc. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, whereas the value of the lead and zinc is calculated from the average price of all grades.

Tenor of lead and zinc ore and concentrates produced in Illinois, 1920–1923

	1920	1921	1922	1923
NORTHERN ILLINOIS				
Total crude ore, short tons	312,000	81,400	66,150	86,100
Total concentrates in crude ore:				
Lead, per cent	.35	.85	1.18	.35
Zinc, do	5.77	9.46	12.55	5.54
Metal content of crude ore:				
Lead, do	.26	.66	.88	.25
Zinc, do	1.87	3.44	5.83	1.85
Average lead content of galena concentrates, do	74.8	77.8	74.2	71.0
Average zinc content of sphalerite concentrates, do	32.4	36.4	40.6	33.4
Average value per ton:				
Galena concentrates	$81.21	$53.84	$64.48	$77.54
Sphalerite concentrates	$22.03	$12.57	$19.98	$15.77
SOUTHERN ILLINOIS				
Average lead content of galena concentrates, per cent	74.7	78.0	70.2	67.6
Average value per ton of galena concentrates	$95.27	$60.18	$69.69	$75.68

Mine production of silver in southern Illinois, 1907–1923

Year	Silver		Lead concentrates, silver bearing		Year	Silver		Lead concentrates, silver bearing	
	Fine ounces	Value	Short tons	Ounces of silver per ton		Fine ounces	Value	Short tons	Ounces of silver per ton
1907–1915	25,220	$14,371	4,199	6.00	1920	8,193	$8,930	1,252	6.55
1916	5,684	3,740	874	6.50	1921	1,345	1,345	181	7.43
1917	7,186	5,921	1,239	5.80	1922	6,025	6,025	1,100	5.48
1918	8,171	8,171	1,228	6.65	1923	8,170	6,699	1,762	4.64
1919	4,440	4,973	715	6.16					

The value of the mine production of silver, lead, and zinc in Illinois in 1923 was $372,215, as compared with $507,911 in 1922. The decrease was due entirely to the smaller quantity of zinc shipped, as both lead and silver increased in quantity.

The lead and zinc deposits of Illinois fall into two distinct regions marked by different mineral associations and structural environment. Those of southern Illinois belong to the Kentucky-Illinois fluorspar district; those of northern Illinois belong to the upper Mississippi Valley region.

NORTHERN ILLINOIS

The lead and zinc mines of northern Illinois are all in Jo Daviess County, the extreme northwestern county of the State. The ores are galena, smithsonite, and sphalerite, though the first two are much less common now than formerly, when the deposits worked were mostly shallow and above water level.

Although the lead output of northern Illinois, Wisconsin, and Iowa has been large in the past, and the ores have been smelted near the mines,[3] the output in recent years has been comparatively small, and no ores have been smelted in those States.[4] The galena is practically nonargentiferous, and the zinc ores are not known to

[3] Cox, G. H., Lead and zinc deposits of northwestern Illinois: Illinois Geol. Survey Bull. 21, p. 14, 1914.
[4] Pulsifer, H. B., History of lead smelting in Wisconsin: Min. and Eng. World, May 2, 1914, p. 821.

contain cadmium. Marcasite is very commonly associated with the ores, generally in such quantity as to necessitate roasting and magnetic separation.

The entire output of northern Illinois is included under the Galena district, which comprises the mines from the vicinity of Fever River to the Wisconsin State Line.

A small increase in quantity of crude ore and considerable decreases in concentrates are shown in the accompanying tables. The percentages of both lead and zinc concentrates recovered decreased, as did also the precentages of metal contents in the crude ore.

The largest quantity of zinc concentrates was derived from the North Unity mine of the Vinegar Hill Zinc Co. Most of the lead concentrates and some zinc concentrates came from the Black Jack mine of the Mineral Point Zinc Co., which was reopened in 1923. Some prospect work was done by Gus E. Brown on the Barnes land, and a shaft was sunk and a number of miners, including Al Davey, were prospecting for galena. The North Unity and Black Jack were the only properties operated to any extent during the year.

SOUTHERN ILLINOIS

The lead and zinc deposits of southern Illinois are found in Pope and Hardin counties in rocks of Mississippian age in the northern extension of the Kentucky-Illinois fluorspar district. The principal product of the mines in recent years has been fluorspar, and the yield of galena is small compared with the output from other districts in the Central States.

The total production of galena concentrates in southern Illinois from 1906 to 1923 has been 12,753 tons, most of which has been shipped from the Fairview, Rosiclare, and Hill Side mines. The shipments of zinc ores from the district have been comparatively small and scattered. The only recorded shipments of zinc carbonate, aggregating 103 tons, were made from the Empire mine in 1903 or 1904 and from four companies in 1906.

Formerly large bodies of galena near the surface were worked, but galena is now produced incidentally in the concentration of the fluorspar. For this reason it would be misleading to give the quantity of crude ore. The galena of southern Illinois is notably argentiferous as compared with the rest of the Mississippi Valley ores, and the silver content averaged for the last seven years from 4.64 to 7.5 ounces to the ton of lead concentrate.

Sphalerite, or zinc blende, occurs much less plentifully than galena, and the first shipments of sphalerite in many years were made from the new plant of the Fairview Fluorspar & Lead Co. in 1923. It is recovered as zinc middlings in the concentration of the fluorspar. The difficulty of making a clean separation of the zinc middlings has kept down the production of zinc.

The shipments of galena concentrates increased from 1,100 tons in 1922 to 1,762 tons in 1923, and the silver recovered in treating the concentrates increased from 6,025 to 8,170 ounces.

The Fairview Fluorspar & Lead Co. operated the Good Hope vein, which was first developed in 1862. Three shafts were operated at levels from 50 to 400 feet in 1923. The new experimental 250-ton mill designed to treat the zinc ore that occurs in the mine workings,

of which there is a considerable quantity on the dump, was run during the year, and some sphalerite was shipped.

The Rosiclare Lead & Fluorspar Mining Co. operates on an ore body that is probably continuous with that of the Fairview. The mill, designed to handle 500 tons a day and provided with special facilities for saving the lead and zinc, both by jigs and by tables, was idle most of the year, and only a small quantity of galena was shipped. The Hillside Fluorspar Co.'s new mine and concentrating plant near Rosiclare was operated in 1923. The shaft is 350 feet deep and the milling plant has a capacity of 200 tons (8-hour shift). The galena ore, assaying 70 per cent lead and about 4.5 ounces of silver a ton, was shipped to the St. Louis plant of the National Lead Co.

IOWA

The lead and zinc deposits of Iowa extend along Mississippi River for nearly 80 miles, in Dubuque, Clayton, and Allamakee counties. No shipments of lead or zinc concentrates from mines in Iowa have been reported since 1918.

KANSAS

By J. P. Dunlop

Mine production of lead and zinc in Kansas, 1923, by districts [a]

District	Lead concentrates		Zinc concentrates (sphalerite)		Metal content			
					Lead		Zinc	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Badger-Peacock-Crestline	400	$34,807	86	$3,225	317	$44,380	42	$5,712
Blue Mound-Baxter Springs	22,023	2,139,263	169,945	6,925,479	17,142	2,399,880	89,817	12,215,112
Galena	[b] 154	11,122	489	20,594	112	15,680	239	32,504
Waco (in Kansas)	36	2,700	19,934	814,016	27	3,780	10,871	1,478,456
Total, 1922	22,613	2,187,892	190,454	7,763,314	17,598	2,463,720	100,969	13,731,784
	29,436	2,300,110	104,219	3,498,030	23,271	2,559,810	56,225	6,409,650

[a] In calculating the metal content of the ores from assays, allowance has been made for smelting losses of both lead and zinc. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, while the value of the lead and zinc is calculated from the average price for all grades.

[b] Includes 26 tons of lead carbonate from Galena.

Tenor of lead and zinc ore and concentrates produced in Kansas, 1921–1923

	1921	1922	1923
Total crude ore, short tons	1,132,000	2,151,200	2,680,700
Total concentrates in crude ore:			
Lead, per cent	2.00	1.37	0.84
Zinc, do	6.05	4.85	5.98
Metal content of crude ore:			
Lead, do	1.63	1.10	.67
Zinc, do	3.63	2.90	3.59
Average lead content of galena concentrates, do	81.6	80.6	79.4
Average zinc content of sphalerite concentrates, do	60.1	59.9	60.0
Average value per ton:			
Galena concentrates	$53.79	$78.14	$96.78
Sphalerite concentrates	$23.16	$33.56	$40.76

The lead and zinc deposits of Kansas, so far as developed, are limited to Cherokee County, in the southeastern part of the State. They form the western extension of the ore deposits of the Joplin region and display the general characteristics shown in that region, except that here typical sheet-ground deposits have not been extensively developed.

It is difficult to ascertain the production for early years or to segregate the Kansas ores from those produced in the Missouri portion of the Joplin region. If to the figures for 1886 to 1903, published by the Kansas Geological Survey,[5] are added those for 1904 to 1923, published by the United States Geological Survey, a total of 1,704,453 tons of zinc concentrates and 272,034 tons of lead concentrates is shown as the approximate production of Kansas for 1886 to 1923. About 60 mines, of which 39 are in the Blue Mound-Baxter area, shipped lead or zinc in 1923.

The older mining camps at Lawton and Badger-Peacock produced much less zinc and lead in 1923 than in 1922, and nearly all the production from Kansas came from the Blue Mound-Baxter district, an extension of the Miami field, and the Waco camp, on the Kansas-Missouri State line. The Crestline district was being unwatered, and the output was comparatively small. Several mills are ready for operation and will probably produce in 1924.

The decrease in lead concentrates was due to the lower recoveries of lead from the new mines near Blue Mound, whose mills treated about 83 per cent of all the crude ore mined in Kansas.

The zinc content of the sphalerite from the Waco district was about 61.5 per cent, and that from the Blue Mound-Baxter district about 59.8 per cent.

Badger-Peacock-Crestline district.—The production of the Badger-Peacock-Crestline district, including shipments of galena and sphalerite from mines west of Badger, was 400 tons of galena and 86 tons of sphalerite, against 305 tons of galena and 83 tons of sphalerite in 1922. Lessees of the Connor land and Middlesex land, shipped galena and sphalerite. The Jackson mine, on the Chanute Spelter Co.'s lease, was operated by Andrew Bros., who deepened the shaft and built a larger milling plant. The Kanok Mining Co.'s mill (200 tons) was not operated. Shafts have been sunk to the lower run of ore, and a large output is expected in 1924.

The Ellis and Crutchfield mills and mines of the Interstate Lead & Zinc Co. have been sold to the Eagle Picher Lead Co. A heavy flow of water was struck on these leases, which prevented operation of the mills in 1923. Churn-drill holes 30 inches in diameter were drilled and electric pumps were installed in the holes in order to avoid sinking shafts through the flooded ground. The experiment was successful, and the water level has receded so much that a large output is expected in 1924.

The Underwriters Land Co. drilled its lease on the Moore land, sunk a new shaft, and began the construction of a milling plant. The Sparks lease had a small output of lead from a new shaft. Most of the land adjacent to the present mining area has been leased and drilling was done by the Kansas Exploration Co., Barnsdall Zinc Corporation, and other large operators.

[5] Haworth, Erasmus, and others, History, geography, geology, and metallurgy of Galena-Joplin lead and zinc: Kansas Univ. Geol. Survey, vol. 8, 1904.

Lawton-Waco district.—The output of the Lawton-Waco district came from the mines near Waco, as the one producing property at Lawton—that of the Eastern Lead & Zinc Co.—was idle. The total output of the Waco district, lying partly in Missouri and partly in Kansas, was 47,030 tons of sphalerite and 175 tons of galena, against 31,238 tons of sphalerite and 312 tons of galena in 1922. The production of the Kansas portion of the district was 19,934 tons of sphalerite and 36 tons of galena, as compared with 10,200 tons of sphalerite and 152 tons of galena in 1922. The principal producing properties in the Kansas part of the district were the Butté Kansas Nos. 1 and 2, which were operated most of the year. Five shafts were operated at the two mines in ore at 200 to 230 feet. One mill has a capacity of 500 tons a shift, and the other of 150 tons a shift. Barnsdall No. 3 had a large production. Four shafts were used to hoist ore for the 500-ton mill. Freehold No. 3, the only other producing mine on the Kansas side, was operated by sublessees.

Galena district.—The production of lead concentrates in the Galena district was 154 tons, as compared with 174 tons in 1922. There were small shipments of sphalerite concentrates derived from old dumps cleaned at chat mills, and some sphalerite held in bins at the Murphy and Kiowa mines since 1921 was shipped. Some of the sphalerite was produced at the R. C. Shellac custom mill, and the output was derived from clean-ups or from shallow mining, as the mines in this field are flooded and no pumping was done in 1922 or 1923.

Blue Mound-Baxter Springs district.—There was considerable activity in that part of Cherokee County south and west of Baxter Springs and north of the Oklahoma State line. The Kansas Exploration Co. continued its extensive drilling campaign, covering a large section of Cherokee County, frequently operating 20 to 25 drill rigs. The Eagle Picher Lead Co., Federal Mining & Smelting Co., Black Eagle Mining Co., Chubb Mining Co., Lucky Jew Mining Co., and Commerce Mining & Royalty Co. explored with drills a large part of the territory northwest and northeast of Picher. New shafts were sunk, several new mills were erected, and a number of properties changed hands.

Most of the output in 1923, as in 1922, came from mines north and northwest of the Picher area and close to the State line, and mines north of Hockerville and east and north of Blue Mound produced 1,583 tons less lead than in 1922 but shipped 7,537 tons more sphalerite concentrates in 1923 than in 1922.

The shipments of concentrates from the Blue Mound-Baxter area, which in 1922 amounted to 28,805 tons of galena and 93,826 tons of sphalerite, were 22,023 tons of galena and 169,945 tons of sphalerite. The average lead content of the galena sold was 79.4 per cent, and the zinc content of the sphalerite concentrates sold was 59.8 per cent. The crude ore ("dirt") milled yielded 7.09 per cent in concentrates, and at some mines the recovery was more than 10 per cent. Of the total shipments 79 per cent came from mines west and northwest of Blue Mound, which shipped 64 per cent in 1922. About 90 per cent of the lead shipped from the district came from mines west and northwest of Blue Mound. The sales of zinc concentrates were much larger than the production, and the only large stock of sphalerite in bins at mines near Blue Mound was that at the Webber mine, and

that stock was nearly all sold and shipped late in 1923 and finally cleaned up in February, 1924.

The producing properties in the area west and northwest of Blue Mound were the State Line Zinc Co. (Blue Diamond), McGehee Bros. (Blue Mound tailings), Vinegar Hill (Barr), Webber, West Side, Early Bird, Southern, Crescent, Tar Creek (old Tampa), Wade, Chubb, Tulsa Quapaw, Cherokee, Lucky Jew, Black Eagle No. 2, Kansouri, Fox, Bendelari, Big Elk, Lawyers, Redskin, King Brand, and Muncie. The producing properties north of Hockerville and Zincville and east and north of Blue Mound were the Hartley, Brewster, East Side, Ebenstein (Chanute Spelter Co.), Kansas Line, Commonwealth No. 2, Euterpe, Lucky O. K., English O. (now the Eagle), Empire, Homestake, Baxter, Brugger, and Queen Esther.

New concentrating plants were erected by the Andrew Mining Co. (150 tons), Baxter Mining Co. (100 tons), Tulsa Quapaw Mining Co. (600 tons), Chubb Mining Co. (300 tons), Race Track Mining Co. (150 tons), and Cherokee Mining Co. (250 tons).

The Barr, West Side, Webber, Southern, King Brand, Blue Diamond, Southern, Lawyers, Black Eagle, Muncie, Chubb, Lucky Jew, and Early Bird mines each shipped more than 500 tons of galena in 1923. The mines that shipped more than 3,000 tons of sphalerite in 1923 were the Barr, West Side, Webber, Southern, Big Elk, Wade, King Brand, Redskin, Lucky Jew, Queen Esther, Empire, Black Eagle, Cherokee, Chubb, Brewster, Muncie, Lawyers, Bendelari, Early Bird, and Homestake.

The old Tampa mine was taken over by the Tar Creek Mining Co., the Weneeda by the Eagle Picher Mining Co., the Kansouri, Homestake, and Muncie by the Federal Mining & Smelting Co., the Bethlehem by the Wade Zinc Co., the English O. by the Eagle Mining Co., and the D'Armand by the Lawyers Mining Co.

Shafts were sunk and a new mill was under construction by the Kansas Exploration Co. The Eagle Picher Lead Co. and the Commerce Mining & Royalty Co. sank some new shafts in 1923 and have some leases ready for mills when they require new producing mines.

KENTUCKY

By J. P. Dunlop

Lead and zinc deposits are found in both central and western Kentucky. None of the mines in the central districts reported any lead or zinc concentrates shipped in 1923. The deposits in the fluorspar region of western Kentucky are chiefly in Crittenden, Caldwell, and Livingston counties and form a continuation of those in the southern Illinois lead and zinc region.

Considerable quantities of galena ores have been produced in former years, but at present lead is obtained solely as a by-product in the recovery and concentration of fluorspar, which is the principal economic mineral. The galena recovered is argentiferous, the silver content ranging from a very small quantity to more than 3 ounces a ton, but no recovery of this silver content has been reported by the smelters during the last 12 years.

Mine production of lead and zinc in Kentucky, 1907–1923

Year	Lead concentrates (galena)		Zinc concentrates				Metal content			
			Sphalerite		Zinc carbonate		Lead		Zinc	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1907–1915	709	$31,602	723	$31,717	4,909	$160,669	480	$44,390	2,040	$342,886
1916	227	16,868	125	6,407	2,923	126,875	153	21,114	1,096	293,728
1917	184	15,415	.....	.....	2,299	78,368	123	21,156	751	153,204
1918	255	21,066	.....	.....	927	30,390	185	26,270	315	57,330
1919	120	7,250	.....	.....	120	3,600	86	9,116	36	5,256
1920	172	12,295	.....	.....	25	750	122	19,520	9	1,458
1921	100	3,693	.....	.....	621	19,800	69	6,210	220	22,000
1922	132	8,365	.....	.....	419	8,373	92	10,120	142	16,188
1923	78	6,152	.....	.....	850	17,925	53	7,420	270	36,720

The average lead content of galena concentrates in 1922 and 1923 was 69.2 per cent. The total value of the lead and zinc concentrates shipped from Kentucky mines was $24,077, against $16,738 in 1922.

The principal sellers of galena concentrates were the Kentucky Fluorspar Co., Eagle Fluorspar Co., Roberts Fluorspar Co., and Keystone Fluorspar & Lead Co. The Zinc & Spar Co. operated the Hudson mine, near Salem, in Livingston County, part of the year. The zinc carbonate ore was taken from workings about 85 feet in depth and treated in log washers before shipment.

MICHIGAN

By F. Begeman

PRODUCTION

The smelter output of refined copper in Michigan in 1923 was 137,691,306 pounds, as compared with 122,545,126 pounds in 1922. The difference between the mine and the smelter production is due to the fact that the quantity of concentrates or "mineral" produced is not the same as the quantity smelted. A company may produce either more or less "mineral" than it smelts during the year.

Mine production of silver and copper in Michigan in 1922 and 1923[a]

Year	Silver (fine ounces)	Copper			Concentrate ("mineral")		Ore ("rock") (short tons)
		Pounds	Yield		Pounds	Yield (per cent)	
			Pounds per ton of ore ("rock")	Percentage			
1922	376,990	[b] 121,712,365	24.6	1.23	[c] 193,984,975	62.7	[d] 4,952,264
1923	[e] 223,997	[b] 138,304,080	25.8	1.29	[e] 220,055,091	62.8	[d] 5,363,160
Increase or decrease	−152,993	+16,591,715	+1.2	.....	+26,070,116	.....	+410,896

[a] The figures are based on the actual recovery of copper from "mineral" smelted and the estimated recovery from "mineral" that was not smelted during the year.
[b] Includes copper from sands.
[c] Includes "mineral" from sands.
[d] Includes sands.
[e] Derived from the electrolytic treatment of 9,151,122 pounds of copper.

Value of silver and copper produced in Michigan mines in 1922 and 1923

Year	Silver	Copper		Total
		Total	Per ton of ore ("rock")	
1922	$376,990	$16,431,169	$3.32	$16,808,159
1923	183,678	20,330,700	3.79	20,514,378
Increase or decrease	−193,312	+3,899,531	+.47	+3,706,219

HOUGHTON COUNTY

Houghton County occupies the central portion of the copper belt and contains 8 of the 10 mines that produced copper in 1923.

According to the annual report of the Calumet & Hecla Consolidated Copper Co. the consolidation of the Ahmeek, Allouez, Calumet & Hecla, Centennial, and Osceola Consolidated mining companies became effective September 1, 1923. In the eight months of the year before that date the Ahmeek mine produced 17,811,031 pounds of copper, the Calumet & Hecla 24,413,600 pounds, and the Calumet & Hecla Reclamation 10,634,200 pounds. In the four months beginning September 1 the mines produced 21,259,000 pounds of copper at an average cost when sold, but not including depreciation and depletion, of 11.45 cents a pound. Of this quantity the Calumet & Hecla Reclamation produced 6,267,000 pounds at an average cost of 8.56 cents a pound. The price received for copper delivered during the four months from September 1 to December 31 was 13.58 cents a pound.

At Isle Royale "rock" amounting to 308,940 tons was treated, yielding 8,002,244 pounds of refined copper or an average of 25.90 pounds of copper to the ton. The average cost per pound of copper was 16.26 cents, including 3.81 cents for depreciation and depletion. Since its organization the company has disbursed $2,400,000 in dividends.

The mines of the La Salle Copper Co. and the Superior Copper Co. were idle.

The annual report of the Copper Range Co. (Baltic, Trimountain, and one-half Champion, combined) contains the following statement regarding its production:

> In 1923 the production of all mines was 23,571,360 pounds of refined copper, a decrease of 5,458,114 pounds from last year. The suspension of production at Trimountain accounts for 3,834,618 pounds of this decrease.
>
> The Champion Copper Co. produced 18,412,630 pounds of copper, a decrease of 1,171,176 pounds from the previous year. This decrease is accounted for by a reduction of 14 per cent in the average number of men employed in the mine. For the first quarter of 1924 production has been larger than it was in the corresponding months of 1923, and we hope the trend will now be upward instead of downward as has been the case for several years.
>
> Cost per pound of 11.14 cents compares with 9.93 cents in the former year. This higher production cost results from the 20 per cent wage increase made in March, 1923, and higher smelting costs. The latter item has added about 0.4 cent to the cost per pound. In the last few months mining costs have been no higher than the average costs of 1922. Smelting costs have recently been much

improved, although the low tonnage handled causes higher unit costs in this department.

The Baltic mine output dropped 452,320 pounds, and costs of production were higher than since 1920.

The Trimountain Mining Co. was dissolved in 1923, the 300 shares of that company's outstanding stock having been acquired during the year. The Trimountain mine is now directly owned by and operated as a part of the Copper Range Co. No attempt has been made at production since December, 1922, when a large part of the underground force was transferred to the Champion mine. Drifting and sinking were continued throughout the year, however, and 281,482 pounds of copper were produced in the course of this development work. A new steel shaft house was erected at No. 2 shaft for which $59,615.90 was expended.

Total dividends disbursed by the Copper Range Co. up to December 31, 1923, were $27,787,192.

The Wolverine Co. was among the producers of copper in 1923. The published report of the company for the fiscal year ending June 30, 1924, is not yet available, and it is therefore not possible to give a detailed statement of its operations. During the fiscal year ending June 30, 1923, the company stamped 244,310 tons of "rock," which produced 5,431,040 pounds of "mineral," yielding 3,544,879 pounds of refined copper, or 14.509 pounds of refined copper to the ton. The total cost per pound of refined copper was 19.530 cents, including cost of smelting, freight, and marketing product, expenses of eastern offices, taxes, depletion, and depreciation. From its organization to June 30, 1923, the company has produced 180,640,980 pounds of copper and disbursed $10,350,000 in dividends.

On August 16, 1923, the Mohawk Mining Co. purchased the Wolverine mine, and its published annual report for 1923 gives the following statement of operations in the Wolverine mine from that date to the end of 1923:

> There were 69,874 tons of "rock" stamped. The amount of mineral produced was 1,645,750 pounds, and mass 48,570 pounds, making a combined total of mineral and mass 1,694,320 pounds, which yielded 68.67 per cent of refined copper, or 1,170,335 pounds, which amounted to an extraction of 16.82 pounds of copper per ton of "rock" stamped.
>
> Underground operations were scattered throughout old workings of the mine, in upper levels from the third level to the twenty-third, whenever indications of mineralization were present, and consisted of drifting and stoping in blocks of ground passed by in previous years and working over the foot of old stopes as well as blasting out floor pillars.
>
> Numerous places in old workings have been found where the drifting was narrow and at intervals extended partly into the hanging trap, which when cut back to the foot of the lode frequently developed mineralized patches of commercial ground.
>
> This work requires much prospecting in the way of opening up old levels and testing of blocks of ground in advance to provide suitable stamp rock and was restricted by a shortage of labor as well as high wages and cost of supplies.
>
> A quantity of recoverable commercial copper rock remaining in old workings is not to be estimated with any degree of intelligence in advance of a great amount of "dead" work referred to, hence with the prevailing condition in labor and costs and prices of copper any forecast of this mine continuing as a producer is uncertain.

At the Quincy 546,670 tons of "rock" was mined in 1923, which yielded 22,371,330 pounds of "mineral" and 13,000,733 pounds of copper, an average of 23.78 pounds to the ton. The total disbursements in dividends since 1862 amount to $27,002,500.

The mines of the Franklin Mining Co. and the Winona Copper Co. were idle during the year.

KEWEENAW COUNTY

Keweenaw County occupies the northern portion of the copper belt. Development work was continued by the Seneca Copper Corporation during 1923 and production started on a small scale during the later part of the year. A total of 21,644 tons of "rock" was stamped, yielding 948,805 pounds of "mineral," of which 884,169 pounds was smelted, yielding 529,189 pounds of refined copper.

At the Mohawk mine 405,412 tons of "rock" was stamped and yielded 9,452,539 pounds of copper, or an average of 23.32 pounds to the ton. The total dividends to December, 1923, amounted to $10,290,000.

ONTONAGON COUNTY

There were no active mining operations in 1923 in Ontonagon County.

MISSOURI

By J. P. Dunlop

PRODUCTION

The value of the mine production of silver, copper, lead, and zinc in Missouri in 1923 was $26,423,197, compared with $21,789,119 in 1922. The value of copper decreased $77,873 and that of silver $67,295. The value of lead increased $4,138,700 and that of zinc $640,546. The lead content of Missouri lead concentrates sold in 1923 was equal to 31 per cent of the smelter production of primary lead in the United States derived from domestic ores, against 38 per cent in 1922, and the zinc content of Missouri zinc concentrates sold in 1923 was 3.6 per cent of the primary zinc produced by smelters from domestic ores in 1923, as against 4.6 per cent in 1922 and 22.7 per cent in 1917. The approximate number of mines and prospects in Missouri that shipped lead or zinc concentrates in 1923 was 70.

Mine production of copper and silver in Missouri, 1910–1923

Year	Copper		Silver		Lead concentrates, silver bearing (short tons)
	Pounds	Value	Fine ounces	Value	
1910–1918	3,527,293	$667,666	510,920	$333,582	495,823
1919	1,617,200	300,799	[a] 90,401	101,249	81,000
1920	1,512,539	278,307	[b] 111,128	121,130	90,000
1921	137,591	17,749	69,902	69,902	44,000
1922	797,400	107,649	212,656	212,656	138,000
1923	202,556	29,776	177,270	145,361	118,000

[a] Includes 29,480 ounces of silver from cobalt-nickel-copper ore.
[b] Includes 28,664 ounces of silver from cobalt-nickel-copper ore.

The silver content of the lead ores is so small that it is disregarded in the assay and sale of the concentrates. For this reason the smelter reports must be relied on for the silver production. As may be seen by inspection of the table, the quantity of silver produced in any year bears no direct ratio to the quantity of lead concentrates smelted during that year, for the reason that the silver content is so small in quantity that the silver bullion is stored and refined in batches. Over a series of years the concentrates average more than 1 ounce of silver to the ton.

The North American mine, now owned by the Missouri Cobalt Co., produced no silver, copper, nickel, or cobalt in 1923. The copper was derived from matte recovered in smelting lead ore mined in St. Francois County, in southeastern Missouri.

The value of the metallic content of the lead and zinc concentrates produced in Missouri in 1923 was $26,248,060, an increase of $4,779,246 over that of 1922. The production of lead concentrates (of which all but 196 tons was galena) was 262,442 short tons, as compared with 273,554 tons in 1922. Of the output in 1923, 259,320 tons was derived from southeastern and central Missouri, a decrease of 11,974 tons. The average metal content of the lead concentrates from these districts was 65.9 per cent, as compared with 66.5 per cent in 1922, and the value per ton in 1923 was $74.94 as compared with $54.48 in 1922. The quantity of lead in southeastern and central Missouri concentrates in 1923 amounted to 167,458 tons, a decrease of 9,310 tons.

Shipments of galena concentrates from southwestern Missouri were 2,926 tons, compared with 2,087 tons in 1922. The lead carbonate concentrates amounted to 196 tons, an increase of 23 tons. The quantity of lead from southwestern Missouri, or the Joplin region, was 2,285 tons, an increase of 641 tons. The average metal content of the galena concentrates from southwestern Missouri was 75.6 per cent, and the average price per ton was $83.40, or $13.96 more than in 1922.

The quantity of zinc blende concentrates sold from Missouri mines was 32,156 tons, an increase of 4,312 tons compared with 1922. All the blende concentrate was produced in southwestern Missouri. The average price received was $40.52 a ton, and the average zinc content reported by the sellers was 60.2 per cent, compared with $31.91 and 60.3 per cent in 1922.

The zinc carbonate and silicate concentrates sold amounted to 3,774 tons, or 766 tons more than in 1922. The output in 1923 came entirely from southwestern Missouri. The average metal content of the zinc carbonate and silicate concentrates was 38.6 per cent, and the average price per ton was $26.57, compared with $21.25 in 1922.

The value of lead concentrates from southeastern and central Missouri (which produced about 99 per cent of the lead concentrates) was $19,434,633, or $4,654,764 more than in 1922. The total value of the lead and zinc concentrates from southwestern Missouri was $1,661,050, compared with $1,107,090 in 1922.

The total quantity of crude ore or "dirt" mined and treated in Missouri in 1923 was 6,098,900 short tons. As the total amount received for all classes of lead and zinc concentrates sold in 1923 was $21,095,683, the average value per ton of crude ore or "dirt" mined and treated was $3.46.

In the following tables showing the tenor of crude ore ("dirt") and concentrates from Missouri it has been considered advisable to segregate the ores of different nature. The disseminated lead ore of southeastern Missouri differs radically from the lead and zinc ores of the so-called "soft ground" deposits of southwestern Missouri. Each class of ore has its peculiar problems of mining and ore dressing. The data are given for the ores mined in the Joplin region, but as the recoveries from "sheet ground" were very small

in 1920 and 1921 and there were none in 1922 and 1923, it was not possible to differentiate between the "soft ground" and "sheet ground" recoveries. In general, the tables reflect very closely the conditions of the industry.

The much lower percentage of concentrates recovered from crude ore treated in 1922 and 1923 was due mainly to the large quantity of low-grade ore mined from the open cut at the Oronogo Circle mine, at Oronogo. This low-grade ore was shot down several years ago and contained considerable clay and shale, which not only yielded very small recoveries but also lowered the grade of both the lead and zinc concentrates recovered.

Mine production of lead and zinc in Missouri in 1923, by districts

District	Lead concentrates				Zinc concentrates			
	Galena		Carbonate		Sphalerite		Silicate and carbonate	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Alba-Neck City	86	$7,144			179	$5,737		
Ash Grove	16	960					33	$660
Carthage	5	400			142	5,309		
Duenweg-Porto Rico	74	6,100	3	$180	120	4,800	308	7,685
Granby	596	50,273			553	21,252	2,865	77,110
Joplin	829	69,338	116	8,120	1,281	50,116	518	13,858
Oronogo	449	38,311			2,537	69,584		
Spring City-Beef Branch	90	7,650	77	5,340			20	400
Spurgeon-Seneca-Racine	33	2,640					5	110
Stark City and Wentworth	10	800					18	309
Webb City-Carterville-Prosperity	551	45,746			248	7,658		
Waco (in Missouri)	139	10,663			27,096	1,138,637		
Hickory County-Christian County	48	4,020					7	140
	2,926	244,045	196	13,640	32,156	1,303,093	3,774	100,272
Southeastern Missouri	259,320	19,434,633						
	262,246	19,678,678	196	13,640	32,156	1,303,093	3,774	100,272
Total, 1922	273,381	14,924,798	173	9,750	27,844	888,494	3,008	63,917

District	Metal content [a]			
	Lead		Zinc	
	Short tons	Value	Short tons	Value
Alba-Neck City	67	$9,380	86	$11,696
Ash Grove	12	1,680	11	1,496
Carthage	4	560	75	10,200
Duenweg-Porto Rico	56	7,840	169	22,984
Granby	459	64,260	1,238	168,368
Joplin	702	98,280	822	111,792
Oronogo	290	40,600	1,094	148,784
Spring City-Beef Branch	114	15,960	7	952
Spurgeon-Seneca-Racine	25	3,500	2	272
Stark City and Wentworth	8	1,120	5	680
Webb City-Carterville-Prosperity	408	57,120	114	15,504
Waco (in Missouri)	103	14,420	14,639	1,990,904
Hickory County-Christian County	37	5,180	3	408
	2,285	319,900	18,265	2,484,040
Southeastern Missouri	167,458	23,444,120		
	169,743	23,764,020	18,265	2,484,040
Total, 1922	178,412	19,625,320	16,171	1,843,494

[a] In calculating the metal content of the ores from assays allowance has been made for smelting losses of both lead and zinc. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, whereas the value of the lead and zinc is calculated from the average price for all grades.

Tenor of crude lead and zinc ore and concentrates produced in southwestern Missouri in 1921–1923

	1921	1922	1923
Total crude ore, short tons	243,300	727,300	784,000
Total concentrates in crude ore:			
Lead, per cent	0.73	0.31	0.4
Zinc, do	8.04	4.24	4.58
Metal content of crude ore:			
Lead, do	.57	.23	.3
Zinc, do	4.95	2.47	2.65
Average lead content of galena concentrates, do	78.4	75.7	75.6
Average lead content of lead carbonate concentrates, do	58.8	56.1	60.2
Average zinc content of sphalerite concentrates, do	61.7	60.3	60.0
Average zinc content of silicates and carbonates, do	38.3	39.2	38.6
Average value per ton:			
Galena concentrates	$50.15	$69.44	$83.40
Lead carbonate concentrates	32.76	56.36	69.60
Sphalerite concentrates	25.18	31.91	40.52
Zinc silicates and carbonates	10.57	21.25	26.57

Tenor of crude lead ore and concentrates in southeastern Missouri disseminated-lead district in 1921–1923

	1921	1922	1923
Total crude lead ore, short tons	5,058,800	5,152,400	5,314,900
Galena concentrates in crude ore, per cent	5.54	5.26	4.88
Lead content of crude ore, do	3.60	3.50	3.21
Average lead content of galena concentrates, do	65.0	66.5	65.9
Average value per ton of galena concentrates	$41.87	$54.48	$74.94

In Mineral Resources for 1914, Part I, pages 72–77 and 97–100, was given a brief history of lead and zinc mining in the southeastern Missouri and Joplin regions, together with data relating to the total lead and zinc production, the mining and milling practice, the character of the ore and concentrates, and the methods of selling them.

SOUTHWESTERN MISSOURI

AREA AND PRODUCTION

The southwestern Missouri lead and zinc areas include the largest part of the Joplin region, the remainder lying in southeastern Kansas and northeastern Oklahoma.

Lead and zinc concentrates produced in the Missouri part of the Joplin region, 1907–1923

	Short tons	Value	
		Total	Average
Lead concentrates	443,877	$28,173,485	$63.47
Sphalerite concentrates	2,775,612	141,523,076	50.99
Zinc carbonate and silicate concentrates	295,055	9,138,813	30.97
	3,514,544	178,835,374	

PRICES

The following quoted base prices apply not only to southwestern Missouri, but also to all the mines in Oklahoma and Kansas that are in the Joplin region. The average quoted base prices for 60 per cent

sphalerite were highest during March, 1923. The prices were $40 to $41 a ton in the first week in January, $40 the later part of January, and $41 to $45 in February. The March prices were from $47 to $50, but the April prices decreased from $45 to $41, and the May prices were $37.50 to $38. Prices continued to decrease again in June, averaging $37 to $33, the lowest of the year, and were about $37 during July. During the later part of August they advanced to $40, but in September declined to $38. In October they advanced to an average of $39.50 to $40, in November they were $40.50 to $41.50, and in December $40.50 to $41.

Base prices for calamine or zinc silicate ores quoted during 1923 were much higher than in 1922, and the demand was better, though production did not increase to any extent. An increased output from Granby and a greater demand increased the price to about $24 to $25, and some ore was sold during 1923 for $27 to $31 a ton.

The quoted price for galena carrying 80 per cent of lead showed wide variations. In January it was $93 to $102 a ton; in July $60. Prices for galena were unsteady at $93 to $104 a ton during January and February, advanced to $121 a ton at the end of March, and decreased from $115 to $105 the end of April. In May the price was $90, and in June as low as $75. Early in July it slumped to $60, but at the end of July it had advanced again to $75. In August prices were $75 to $80, in September $83 to $85, in October $80 to $83, in November $79 to $82, and in December $85 to $105, the higher figure coming at the end of the year.

Average prices per ton paid for sphalerite and zinc and lead concentrates in southwestern Missouri, 1916–1923

	1916	1917	1918	1919	1920	1921	1922	1923
Sphalerite	$82.60	$71.04	$51.27	$40.67	$45.79	$25.18	$31.91	$40.52
Zinc silicate or carbonate concentrates	50.21	40.50	32.27	27.30	35.50	10.57	21.25	26.57
Galena concentrates	84.29	101.90	89.92	66.82	97.84	50.15	69.44	83.40

These prices are not averages of base-price quotations but averages calculated from the quantity sold and the amounts received as reported to the United States Geological Survey by the sellers.

GENERAL CONDITIONS

Though prices for both lead and zinc concentrates were much higher than in 1922, there was no considerable increase in the total mine output from the Missouri part of the Joplin region, there was no development or mining of "sheet ground," and few properties are now equipped with plants. The high prices paid for lead did not result in any great increase in the output, and the number of small operators and prospectors developing their own mines was not nearly as large as in former years. The old-time small miner has almost vanished, so that the yield of zinc silicate and lead is now comparatively small. There was, however, a greatly increased amount of drilling done in Missouri by large operators, which will result in new mines being opened. The Missouri portion of the Waco district produced more than 84 per cent of the entire output of sphalerite shipped from southwestern Missouri in 1923, and most

of the remainder was shipped from the Oronogo camp. The mines at Waco that contributed the 27,096 tons of sphalerite and 139 tons of galena were those of the Barnsdall Zinc Mining Co., Allegheny Western Mining Co., American Zinc, Lead & Smelting Co., Tulsa–Pittsburg Mining Co., Freehold Oil & Gas Co., and Pyramid Mining Co. No concentrates were sold from any mines in the Thoms Station, Sarcoxie–Reeds, Aurora, Alba, Wentworth, Cave Springs, and Springfield districts.

There was considerably more prospecting in 1923 than in 1922, especially during the fall. A demand for zinc carbonate and silicate at fair prices caused the reopening of some old mines and prospecting for new ones in the Granby, Duenweg, Spurgeon, Racine, and Joplin districts, and 3,774 tons of zinc silicate was shipped. The higher prices for galena and sphalerite resulted in a number of drills being operated in the older camps and an extensive drilling campaign in the area lying between Oronogo, Alba, and Neck City and the productive mines at Waco.

The production in the Neck City, Spring City, Ash Grove, Stark City, Duenweg, Webb City–Carterville, and Spurgeon districts was scattered and small. The only active property at Carthage was that of the Lucky Eleven Mining Co.

The Oronogo Circle plant milled the largest quantity of ore in Missouri, but the recovery of concentrates was small and of low grade, so that operations were suspended late in the year, and the plant is being dismantled. The property, however, has been leased and a smaller mill built to handle the higher-grade dirt that will be mined by lessees from the old stopes and not from the lower-grade ore in the open cut. No large plants near Joplin were operated steadily, but a number of small operators shipped 829 tons of galena, 116 tons of lead carbonate, 1,281 tons of sphalerite, and 518 tons of zinc silicate. Most of the output came from lessees of the Mattes land (old Bullfrog), F. F. Creller, J. W. McCulloch, C. M. Wirts and the American Zinc, Lead & Smelting Co.

The Webb City-Carterville-Prosperity district had a small output compared with that of former years. The shipments were 55 tons of galena and 248 tons of sphalerite. The largest production of both lead and zinc was made by lessees on the Connor land. Other properties that yielded shipments of lead or zinc were those of the American Zinc, Lead & Smelting Co., Center Creek Mining Co., Eleventh Hour Mining Co., and old Troop 40 acres. Most of the shipments from the district consisted of ores from scrapping and clean-ups. At the end of 1923 few companies were mining ore in southwestern Missouri, and the only large plants in operation were the Barnsdall, Allegheny Western, American Zinc, Lead & Smelting Co., Freehold Oil & Gas Co., Pyramid Mining Co., and Tulsa-Pittsburg, at Waco; the Clear Preacher, at Duenweg; numerous lessees on the American Zinc, Lead & Smelting Co.'s land at Granby; the Joe Bob and Krape, near Joplin; and the Lucky Eleven mine, near Carthage.

CENTRAL AND SOUTHEASTERN MISSOURI

A brief description of the ore deposits in central and southeastern Missouri is given in the chapter entitled "Silver, copper, lead, and zinc in the Central States in 1915," which may be obtained upon

application to the Director, United States Geological Survey, Washington, D. C.

Copper, nickel, and cobalt occur in the ore in considerable quantity in the vicinity of Fredericktown and in small quantity irregularly in nearly all deep mines. It is only near Fredericktown that the copper, nickel, and cobalt content of the ore has been the object of mining, yet a concentrate of these metals has been recovered as a table middling at several plants in other parts of the district.

In the disseminated-ore district the production after 1869 increased rapidly and is estimated by Buckley to have amounted to 1,202,607 tons of lead concentrates, valued at $59,869,354, for the period between 1869 and 1906, inclusive. The mine production of southeastern and central Missouri has been reported to the United States Geological Survey since 1907.

Mine production of lead and zinc concentrates in southeastern and central Missouri, 1907–1923

Year	Lead concentrates (galena)		Zinc concentrates			
			Sphalerite		Carbonate and silicate	
	Short tons	Value	Short tons	Value	Short tons	Value
1907–1915	1,945,996	$85,207,971	452	$13,108	8,435	$168,929
1916	307,025	20,720,737	365	14,400	1,030	42,129
1917	306,473	30,070,995	186	16,344	293	7,145
1918	271,506	20,507,064	13	285	235	6,845
1919	229,687	11,590,977	----------	----------	231	6,576
1920	242,248	19,799,389	----------	----------	61	1,910
1921	280,358	11,737,400	----------	----------	----------	----------
1922	271,294	14,779,869	----------	----------	----------	----------
1923	259,320	19,434,633	----------	----------	----------	----------

The output of silver in Missouri in 1923 was derived from refining pig lead. The silver was recovered from about 118,000 tons of lead concentrates.

The crude lead ore mined in the disseminated-lead district, amounting to 5,314,900 short tons, yielded 4.88 per cent of lead concentrates which averaged 65.9 per cent of lead. The average value per ton of lead concentrates was $74.94, compared with $54.48 in 1922, and the concentrates were slightly lower in lead content than in 1922. The output of galena concentrates was 259,157 tons, against 271,068 tons in 1922. As several of the large producers not only mine but also smelt their lead concentrates, the values given for concentrates are to a certain extent arbitrary. The galena concentrates produced in the southwestern Missouri region, which contain a higher lead content, are sold mainly on bids from purchasers, and the prices for those concentrates are not comparable with prices given for concentrates of the disseminated-lead district.

Analyses of ores mined in the disseminated-lead district in southeastern Missouri and of the various grades of resulting concentrates are given in Mineral Resources for 1919 and 1920.

There were no shipments of zinc carbonate from southeastern Missouri during the year.

The quantity of galena recovered from shallow diggings in Washington and Jefferson counties was only 163 tons. The ore, which occurs at shallow depths in association with barytes, is mined in a small way and at odd times by the barytes miners.

Small sales of lead ore were made by P. G. Higginbotham, of Fertile, the National Pigments & Chemical Co., the Washington Land & Mining Co., and the Valle Mining Co.

The 300-ton concentrating plant and the 100-ton smelter and refinery of the Missouri Cobalt Co., at Fredericktown, were not operated in 1923.

Nearly all the lead produced in southeastern Missouri was mined by the National Lead Co., St. Joseph Lead Co., Desloge Consolidated Lead Co., and Federal Lead Co. The St. Joseph Lead Co., which had already acquired the property of the Baker Lead Co. and that of the old Mine La Motte, took over and operated the Federal Lead Co.'s mines after October 23, 1923. The St. Joseph Lead Co., through a subsidiary, has done a large amount of drilling in the Joplin region. According to the annual report of the company for 1923 the mines in southeastern Missouri produced 2,778,347 tons of crude ore, which yielded 154,283 tons of lead concentrates, and the smelter produced 95,511 tons of pig lead. The St. Joseph Lead Co. now has five concentrating plants—Rivermines, 4,200 tons; Bonne Terre, 2,400 tons; Leadwood, 2,000 tons; Flat River, 5,000 tons; and Elvins, 3,000 tons. Other concentrating plants are those of the National Lead Co., 2,500 tons, and the Desloge Consolidated Lead Co., 1,500 tons.

The Annapolis Lead Co.'s mine in Iron County was under development through the 450-foot shaft. A complete milling plant having a daily capacity of 600 tons was finished and operated in March, and a steam turbine plant was completed.

Additions to the boilers and power plant were made in the mill of the Desloge Consolidated Lead Co., which operated three shafts in 1923.

Some development work that yielded a small quantity of galena was done on the Eagle Picher property, near Morrellton, in Franklin County.

OKLAHOMA

By J. P. Dunlop

Mine production of lead and zinc in Oklahoma in 1923, by districts

District	Lead concentrates (galena)		Zinc concentrates			
			Sphalerite		Carbonate and silicate	
	Short tons	Value	Short tons	Value	Short tons	Value
Miami and Quapaw	85,473	$8,115,798	463,090	$18,731,194		
Peoria	1	70			54	$520
	85,474	8,115,868	463,090	18,731,194	54	520
Total, 1922	79,716	5,988,486	389,144	13,375,413	50	450

Mine production of lead and zinc in Oklahoma in 1923, by districts—Continued

District	Metal content [a]			
	Lead		Zinc	
	Short tons	Value	Short tons	Value
Miami and Quapaw	66,903	$9,366,420	242,407	$32,967,352
Peoria	1	140	14	1,904
	66,904	9,366,560	242,421	32,969,256
Total, 1922	62,856	6,914,160	209,682	23,903,748

[a] In calculating the metal content of the ores from assays allowance has been made for smelting losses of both lead and zinc. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, whereas the value of the lead and zinc is calculated from the average price of all grades.

The following table gives the output of crude lead and zinc ore for the whole State of Oklahoma. Formerly it was thought advisable to calculate the tenor of crude ore and concentrates as well as assay content and value of concentrates separately for the Miami and Quapaw districts, inasmuch as the character of the ground operated in these districts had, until the new mines in the easterly extension of the Miami district, near Quapaw, were opened in 1918, differed so radically that general calculations for the State would have been valueless. Since 1921, however, there has been no necessity for such separation, as all the mills in the Quapaw district, except two or three in the northern part, near Sunnyside and Hockerville, have been idle.

Tenor of lead and zinc ore and concentrates produced in Oklahoma, 1921–1923

	1921	1922	1923
Total crude ore milled in Oklahoma, short tons	2,969,500	6,159,500	7,937,200
Total concentrates in crude ore:			
Lead, per cent	1.76	1.29	1.08
Zinc, do	7.60	6.32	5.61
Metal content of crude ore:			
Lead, do	1.43	1.04	.86
Zinc, do	4.54	3.78	3.34
Average lead content of galena concentrates, do	81.0	80.4	79.9
Average zinc content of sphalerite concentrates, do	59.8	59.9	59.5
Average value per ton:			
Galena concentrates	$52.48	$75.12	$94.95
Sphalerite concentrates	22.83	34.37	40.45

Mine production of lead and zinc concentrates in Oklahoma, 1891–1923, by districts

District	Lead concentrates (mainly galena)		Zinc concentrates			
			Sphalerite		Zinc silicate and carbonate	
	Short tons	Value	Short tons	Value	Short tons	Value
Peoria	2,178	$107,053	220	$8,289	2,842	$74,402
Quapaw	5,054	357,128	40,375	1,720,078	164	2,692
Miami	525,314	41,910,068	2,450,631	104,440,341	----------	----------
Davis	----------	----------	558	27,399	899	24,592
	532,546	42,374,249	2,491,784	106,196,107	3,905	101,686

Mineral Resources for 1914 contains a brief history of mining in the districts in Oklahoma and also the estimated total production of each district, by years.

The total value of the lead and zinc concentrates shipped from Oklahoma in 1923 was about eleven times as much as the value in 1915.

The lead and zinc deposits of northeastern Oklahoma, so far as known, are confined to Ottawa County and form the southwestern extension of the deposits in the Joplin region. There are three camps—Peoria, Quapaw, and Miami—in which extensive mining has been done, and a fourth, the Sycamore Creek district, along the Seneca fault block from 2 to 3 miles southwest of Seneca, Mo., in which considerable prospecting has been done and some ore mined. The lead and zinc deposits in southern Oklahoma are near Ravia, at the southeast end of the Arbuckle Mountains, and near Davis, Murray County, at the northwest end of the same range.

The quantity of crude ore milled in Oklahoma increased 1,777,700 tons in 1923, of which the quantity of ore milled by the old mines near Commerce was about 4 per cent, or about 75,000 tons more than in 1922. The value of the lead and zinc produced at mines in Oklahoma was $42,335,816, compared with $30,817,908 in 1922. The metal content of lead concentrates increased from 62,856 to 66,904 tons, and the zinc from 209,682 to 242,421 tons.

The lead concentrates produced were of slightly lower grade than those shipped in 1922. The average metal content of the sphalerite concentrates from the Miami ore has increased from 51.8 per cent in 1912 to 59.5 per cent in 1923, although the average zinc content of the sphalerite recovered from ore and tailings at the old mines near Commerce in 1923 was only 52.8 and that near Quapaw 56.2 per cent.

The Oklahoma portion of the Miami field produced about 77 per cent of the total output of lead concentrates in the Joplin region. The Oklahoma shipments of sphalerite increased 73,946 tons and formed 67.5 per cent of the output of sphalerite from the Joplin region.

A history of the mining in the Miami district, including the output by years for 1908 to 1914 and the location of the mines and mills, was given in Mineral Resources for 1914. The reports for 1915 to 1919 contain full reviews of the production, new territory prospected, new mines opened, and new mills erected in those years. A brief description of the ore deposits in the Miami district is given in Mineral Resources for 1915.[6]

About 130 mills in the Oklahoma part of the Miami field in 1923 shipped 85,474 short tons of galena concentrates and 463,090 short tons of sphalerite concentrates, an increase of 5,758 tons of galena concentrates and 73,946 tons of sphalerite concentrates compared with the output of 1922. The average price of the galena concentrates increased $19.83 a ton, and the average price of sphalerite concentrates, of which more than five times as much was shipped, increased $6.08 a ton.

The high prices paid for galena and the increase of more than $6 a ton in the price of sphalerite permitted the mining of ore that was de-

[6] Siebenthal, C. E., U. S. Geol. Survey Mineral Resources, 1915, pt. 1, pp. 888–890, 1917.

veloped but could not be profitably extracted in 1921 and 1922. The percentage of concentrates recovered was slightly less than in 1922, but the total quantity of crude ore milled increased nearly 29 per cent. Some drilling was done outside the proved area, but little new territory was added, though drilling disclosed new ore bodies of probable value west and east of territory now actively mined. Many leases expired and were renewed at a lower royalty on Indian lands.

The total quantity of crude ore milled in the Miami region in Oklahoma and Kansas in 1923 was about 10,618,000 tons, and shipments of lead and zinc concentrates exceeding $100,000 in average value were made by each of 110 companies in this region. There were more drill rigs and more shafts and milling plants in operation in this small area than in any other district in the United States.

Labor was plentiful and efficient. Late in 1923 efforts were being successfully made to organize the men in a union. It is stated that in April, 1924, several local unions were active and that their members were largely outsiders who had come to the region recently, few of the old Joplin miners having joined. All the miners are provided with adequate shipping facilities by rail and roadway. Many additions were made to switches and sidetracks, and the Northeast Oklahoma Railroad extended its tracks several miles into Kansas, as far as Columbus, and ran side tracks to many of the mines in the northwestern section of the region.

The quantity of sphalerite concentrates in bins at mines on December 31, 1923, was about 40,000 tons less than that in bins on January 1, As the mines and mills in the Joplin region, if run at capacity on double shift, could if required produce more zinc concentrates than are needed to supply the demand for zinc, the mine operators controlled their output by running single shift and by closing mines temporarily on several occasions. This resulted in the reduction of ore in stock, saved the operators from selling below cost of production, and permitted the mining of lower-grade dirt. The high price paid for galena enabled many miners to operate at a fair profit ore bodies which could not have been worked had the rock hoisted contained only sphalerite.

One of the features of the year was the increasing tendency of the large companies to expand their holdings and operations and the gradual elimination of the small operator. The changes in the ownership of mines, the opening of new mines, and the erection of new concentrating plants were as follows:

Near Hockerville and St. Louis: Hope mine unwatered, new shaft sunk and mill repaired; Indiana mill rebuilt and enlarged after fire; Lucky O. K. No. 2 reopened and operated; Old Sequoyah drilled by Smith & Davis, new shaft sunk and mill repaired; Toltec mine purchased by the H. & K. Mining Co.

Near Quapaw and Sunnyside: The Quapaw Mining Corporation lowered the water on the large tract of ground leased from Indians, repaired the old Springfield mills on the lease, and sank new shafts at the Muskogee, Imperial, and First National mines preparatory to mining. The only mines operated in Oklahoma in 1923 by this corporation were the Wolverine and Tom L. The Reliance Mining Co. sank a shaft and started the erection of the mill purchased from the Blue Ribbon lease at Picher.

Near Century and Douthat: New mines were opened and mills built by the Pat Mining Co., Big Jim Mining Co., and Bullfrog Mining Co., and tailing mills were built and moved to new locations by the Clark Concentrating Co. and Dudley Milling Co.

Near Cardin and Tar River: The Oklahoma Woodchuck mill was burned and was being rebuilt farther west on the lease; the Lucky Junction mill was sold, and the crude ore hoisted was milled at the adjoining Lucky Bill mill; the Rialto Mining Co. acquired the Wingfield lease and sank a new shaft; the Republic mine and mill were taken over by the H. & M. Mining Co.; the Potosi lease was mined by the Golden Rod Mining & Smelting Co.; the Anna Beaver property was reopened after a long period of idleness; and the Hartford lease was transferred to the Goodeagle Mining Co.

Near Picher: The Ohimo mine and mill were purchased by the Grace B. Mining Co., and the old White lease was operated by the Eagle Picher Lead Co. through the Netta workings. The Hunt and Blue Ribbon mines have also been taken over by the Eagle Picher Lead Co. The Whisk Broom and Gordon mines were operated in 1923 and early in 1924 and were sold along with the Lucky Syndicate mine to the Federal Mining & Smelting Co. The Old Standard mine was worked by the S. L. & G. Mining Co.

The production in the Oklahoma part of the Miami field was that of about 130 mills, of which 5 are in the old Commerce camp and the remainder in the territory extending north and northeast to the Kansas State line and east to Quapaw. In the northerly extension of the Miami field in Kansas about 40 mills were in operation at different times in 1923. The quantity of crude ore mined and milled increased from 6,159,500 tons in 1922 to 7,937,200 tons in 1923. The ore treated has showed an increase in concentrates recovered from 5.5 per cent in 1917 to 6.45 per cent in 1918, 6.6 per cent in 1919, 7.05 per cent in 1920, and 9.36 per cent in 1921, and a decrease to 7.61 per cent in 1922 and 6.69 per cent in 1923. The average metal content of the sphalerite was 51.8 per cent in 1912, 58.8 per cent in 1919, and 59.5 per cent in 1923.

The separate assays reported showed the zinc content to range from 46 to 63 per cent, but most of the blende assayed between 59 and 60.5 per cent. An assay of a composite sample of 15,423 samples of ore shipped in 1923 from the Miami-Blue Mound region, made by Bruce Williams, of Joplin, Mo., showed an average content of 59.72 per cent of zinc, 1.48 per cent of iron, and 0.61 per cent of lead. An assay of a composite sample of blende from 1,686 cars shipped in 1923, made by Joe J. Todd, of Miami, Okla., showed 60.3 per cent of zinc and 1.4 per cent of iron. An assay of a composite sample of galena from 310 cars by Mr. Todd showed 79.6 per cent of lead. The average zinc assay as computed from the reports of all the companies selling concentrates differed only 0.2 per cent from that of the composite sample.

The recovery of concentrates from all the mines in Oklahoma averaged about 1 ton of galena to 5.4 tons of sphalerite. The proportion of galena concentrates recovered from the "dirt" mined showed wide variations in different mines, ranging from less than 1 ton of galena to 100 tons of sphalerite to 1½ tons of galena to 1 ton of sphalerite. A few mines reported the recovery of no lead.

The total shipments from those properties that may properly be classed as in the Tar River-Cardin-Douthat area, of which there were a greater number than in the other areas, amounted to 33,766 tons of galena and 193,329 tons of sphalerite. About 3,175,000 tons of "dirt" was milled, and some ore from stocks in bins was shipped, but the recovery in concentrate averaged about 6 per cent, whereas it was nearly 7 per cent in 1922. A few of the mines near Cardin yielded nearly two-thirds as much galena as sphalerite; in a few mines near Douthat the proportion of galena was as little as 3 per cent, and the proportion of galena to sphalerite on the whole was less than that recovered from the mines near Picher but more than that from the mines near Zincville. The proportion of galena to sphalerite recovered at all the mines in the vicinity of Douthat was about 1 ton of galena to 17 tons of sphalerite; in the Tar River section the mines yielded about 1 ton of galena to 4.3 tons of sphalerite.

The territory lying east of Picher, near the Hockerville and Zincville (St. Louis) camps, was more than in 1922, when the shipments from 26 mines were 10,347 tons of galena and 101,432 tons of sphalerite; in 1923 the shipments from 26 mines were 13,166 tons of galena and 130,244 tons of sphalerite from 1,563,000 tons of ore treated. The sphalerite averaged about 59.9 per cent in zinc content and the galena 80 per cent in lead content.

The production of the mines in the vicinity of Picher showed an increase. In 1922 the quantity of ore milled was 2,158,400 tons, and the shipments were 35,080 tons of galena and 130,576 tons of sphalerite. In 1923 the quantity of ore milled was 2,999,300 tons, and the shipments were 34,513 tons of galena and 132,138 tons of sphalerite, with an average recovery of 5.05 per cent in concentrates. The zinc content of the sphalerite averaged about 59 per cent.

At Commerce several old mines, including the Haynes, now worked by the Commerce Mining & Royalty Co., the Midas, Turkey Fat, and Cactus, and the Emma Gordon (leased to the Incas Mining Co.), were reopened and operated in 1923. Shipments from Commerce were 3,111 tons of galena and 2,855 tons of sphalerite. Drilling was more active than in 1921 and 1922, and the production will be larger in 1924.

Shipments from Peoria, the oldest mining camp in Oklahoma, were only a few tons of galena and zinc silicate mined in 1923 by small operators at shallow levels. The total production of concentrates in the Quapaw district was small, and none of the mills near Lincolnville were in operation.

The shipments from mines near Quapaw and Sunnyside were 917 tons of galena and 4,524 tons of sphalerite, most of which came from Vantage No. 2. The Prairie Dog shipped considerable sphalerite before being closed down. The Contract mine sold a small quantity of galena and sphalerite, and the Hope mine was unwatered, the mill repaired, and a new shaft sunk to a body of ore found by drilling southwest of the old shaft.

WISCONSIN

By J. P. Dunlop

Mine production of lead and zinc in Wisconsin in 1923, by districts

District	Lead concentrates		Zinc concentrates				Metal content[a]			
			Sphalerite		Silicate and carbonate		Lead		Zinc	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Benton-New Diggings	638	$54,693	29,178	$573,931	------	------	481	$67,340	8,303	$1,129,208
Cuba City	72	3,905	1,207	28,077	------	------	56	7,840	256	34,816
Dodgeville	------	------	280	5,222	18	$346	------	------	91	12,376
Hazel Green-Livingston	------	------	2,668	46,771	------	------	------	------	802	109,072
Highland-Mineral Point	116	9,329	------	------	1,410	24,735	87	12,180	395	53,720
Linden and Mifflin	102	9,446	5,489	54,247	------	------	77	10,780	902	122,672
Platteville	------	------	3,800	78,558	------	------	------	------	1,105	150,280
Shullsburg	50	3,450	4,966	102,818	------	------	33	4,620	1,357	184,552
	978	80,823	47,588	889,624	1,428	25,081	734	102,760	13,211	1,796,696
Total, 1922	942	62,290	38,795	593,400	562	7,918	691	76,010	10,952	1,248,528

[a] In calculating the metal content of the ores from assays allowance has been made for roasting and smelting losses of both lead and zinc. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, whereas the value of the lead and zinc is calculated from the average price of all grades.

Tenor of lead and zinc ore and concentrates produced in Wisconsin, 1920–1923

	1920	1921	1922	1923
Total crude ore, short tons	1,742,000	136,300	221,000	454,000
Total concentrates in crude ore:				
Lead, per cent	0.20	0.95	0.43	0.22
Zinc, do	5.96	12.07	11.14	9.10
Metal content of crude ore:				
Lead, do	.15	.73	.32	.17
Zinc, do	1.93	3.05	3.58	3.17
Average lead content of galena concentrates, do	75.0	76.1	74.8	76.6
Average zinc content of sphalerite concentrates, do	32.4	25.3	33.9	35.2
Average zinc content of zinc carbonate concentrates, do	26.6	----------	32.8	33.1
Average value per ton:				
Galena concentrates	$92.68	$50.83	$66.13	$82.64
Sphalerite concentrates	22.64	8.52	15.30	18.69
Zinc carbonate concentrates	21.35	----------	14.09	17.56

The crude ore yields from 5 to more than 20 per cent of concentrates. The average recovery in concentrates decreased from 11.57 per cent in 1922 to 9.32 per cent in 1923, reflecting the increase in the quantity of crude ore milled. Some tailings were treated in 1923 at New Diggings and Hazel Green, and about 8,000 tons of sphalerite concentrates in bins at mines milled prior to 1923 were shipped. The mining methods are determined largely by the mode of occurrence of the ores, but otherwise are similar to those in vogue in working the pockety ores at Joplin. The milling methods used in the Wisconsin field have been described by Walter Schultz,[7] of the Wisconsin Zinc Co.

The zinc-carbonate ore, which is mined almost entirely in the Highland and Mineral Point districts, is purchased mainly by the Mineral

[7] Schultz, Walter, Milling Wisconsin lead-zinc ores: Eng. and Min. Jour., July 14, 1917, pp. 82-84.

Point Zinc Co. and made into zinc oxide in the plant at Mineral Point, Wis. Some carbonate ores were produced, and the sales in 1923 were 1,428 tons, or 866 tons more than in 1922.

The metal content of the raw sphalerite concentrates shipped by the mines ranged from 19.4 to 55 per cent, but nearly half of the concentrates sold ranged between 28 and 35 per cent. The zinc content of the roasted sphalerite concentrates shipped was from 59 to 60 per cent.

The value of the mine output of lead and zinc in Wisconsin was $1,899,456, against $1,324,538 in 1922. The lead concentrates sold increased from 942 tons in 1922 to 978 tons in 1923, and the sphalerite concentrates sold increased from 38,795 to 47,588 tons. The metal content of the lead concentrates was 43 tons more than in 1922. The zinc content of the sphalerite and zinc-carbonate concentrates increased 2,259 tons.

Very little development work was done, and very few new mines were opened, though a number of old properties were unwatered and operated.

The lead and zinc mines of Wisconsin are in Grant, Iowa, and Lafayette counties and contain the most valuable part of the ore deposits of the upper Mississippi Valley region, a historical review of which is given in the Illinois section of this report in Mineral Resources for 1914. A detailed description of the Wisconsin lead and zinc districts and of the mines in each district to the year 1906 is given by Bain.[8] The development of the mines subsequent to Bain's report and the output of Wisconsin mines have been set forth in Mineral Resources for 1907 to 1922.

Roasting and electromagnetic separation have been utilized in the district for many years to produce a marketable zinc product. Comparatively few of the concentrating plants are equipped with roasters, but practically all the larger mining interests own or control separating plants.[9] The roasting and separating plants operated in Wisconsin in 1923 were those of the National Zinc Separating Co., at Cuba City; the Blockhouse, at Platteville; the Mineral Point Zinc Co., at Mineral Point; and the Northern Mines Co., at Shullsburg. The shipments made came from about 40 mines, many of which were small and were operated spasmodically.

Approximately 52,400 tons of sphalerite concentrates were shipped in 1923 from mines in the upper Mississippi Valley region (Illinois and Wisconsin), and practically all of this material was treated at roasting and separating plants in Wisconsin. The average zinc content of the raw sphalerite concentrates from Wisconsin sold in 1923 was 35.2 per cent, and the average price per ton was $18.69; the corresponding content and price for 1917 were 32.8 per cent and $29.48; for 1918, 34.6 per cent and $25.70; for 1919, 35.3 per cent and $21.90; for 1920, 32.4 per cent and $22.64; for 1921, 25.3 per cent and $8.52; and for 1922, 33.9 per cent and $15.30.

The percentage of concentrates recovered from crude ore is much higher in Wisconsin than in the Joplin region, but the assay of the raw zinc concentrates shows 20 to 42 per cent less zinc content.

[8] Bain, H. F., Zinc and lead deposits of the upper Mississippi Valley: U. S. Geol. Survey Bull. 294, pp. 81–148, 1906.

[9] Deutman, E. G., The roasting and magnetic separation of Wisconsin zinc ores: Eng. and Min. Jour., June 28, 1919, pp. 1107–1111.

The new concentrating plants are equipped with more tables than formerly. The concentrates from the tables have a very high iron content, but this can be remedied by roasting.

The higher prices in 1923 enabled holders of stored sphalerite concentrates to resume shipment, and more zinc carbonate was mined and shipped from Highland than in 1922, although the quantity was small compared with former years.

Only one of the mines owned by the Mineral Point Zinc Co. (the Hoskins) and one of the Wisconsin Zinc Co. (the Champion) were operated in 1923, but shipments of raw and roasted concentrates were made from ore stored in bins at the Penna-Benton, Middi Coker, Rodham, Imperial, and Ida Blende mines. The larger mines and mills operated in 1923 were the Fields Meloy, Nightingale Hoskins, and Champion, at New Diggings; the Connecting Link, at Cuba City; the Dale Rundell, at Mifflin; the Monmouth, at Hazel Green; the Blockhouse, at Platteville; and the Northern Mines Co., at Shullsburg. The Vinegar Hill Zinc Co. was the only one that operated several mines throughout 1923. The concentrates from its mines and most of the raw concentrates made at other plants were shipped to the National Zinc Separating Co.'s plant at Cuba City and the Mineral Point Zinc Co.'s plant at Mineral Point.

Exclusive of shipments of concentrates recovered in 1920 and 1921 the mines in Wisconsin produced and shipped about 41,000 tons of zinc concentrates in 1923.

The tailings mills operated in 1923 were those of Stadel & Lightcap, at the Cleveland mine; Scott, Cherry & Co., at the Lucky Twelve mine; F. E. Liddle, at the Field Thompson mine; the Domestic Mining Co., at the Champion mine; and the Burr Milling Co., at the Burr mine.

One mill at the Connecting Link mine, near Cuba City, was destroyed by fire in June, 1923. It was rebuilt, but the owners operated only one of the two mills for five months in 1923.

The Dale Rundell mine, at Mifflin, was operated for five months in 1923 by the Vinegar Hill Zinc Co. and was acquired by Billings & Coward, who operated it the remainder of the year.

The roasting plant of the Northern Mines Co., at Shullsburg, erected in 1923, has a capacity of 30 tons a day.

For descriptions of the old mines, concentrating plants, and roasting plants on which no essential changes were made during 1923 the reader is referred to Mineral Resources for recent years.

ZINC [1]

By C. E. Siebenthal and A. Stoll

SUMMARY

Zinc produced and consumed in the United States, 1922–23, in short tons

	1922	1923
Production of primary zinc: [a]		
From domestic ore	353, 274	508, 335
From foreign ore	1, 003	2, 099
	354, 277	510, 434
Production of secondary zinc: [a]		
Redistilled	32, 988	39, 434
Remelted	36, 326	25, 776
	69, 314	65, 210
	423, 591	575, 644
Apparent consumption of primary zinc	373, 090	446, 514

[a] "Primary zinc," which is produced directly from ore, is here distinguished from "secondary zinc," which is obtained by refining zinc ashes, skimmings, drosses, and old metals. The statistics of secondary zinc are given on page 82. Wherever in this report the word "zinc" is used without qualification it means primary zinc.

Owing to necessary economies in Government printing it has been deemed advisable to omit the notes explaining the tables in these reports. The reader will find the full notes in the chapter on zinc in Mineral Resources for 1918. For the same reason the period covered by the tables has generally been limited to the years 1918–1923, and some tables have been omitted.

PRODUCTION

PRIMARY ZINC

Primary zinc produced in the United States, 1918–1923, in short tons

Apportioned according to source of ore

	1918	1919	1920	1921	1922	1923
Total domestic [a]	492, 405	452, 272	450, 045	198, 232	353, 274	508, 335
Foreign:						
Canada	8, 700	4, 007	1, 583	521	55	
Mexico	14, 043	8, 083	8, 978	1, 614	948	2, 099
South America	886	751	536			
Europe	113					
Australia	1, 780	630	2, 235	133		
Total foreign	25, 522	13, 471	13, 332	2, 268	1, 003	2, 099
Total primary	517, 927	465, 743	463, 377	200, 500	354, 277	510, 434

[a] The slab zinc which was rolled is included here.

[1] Chapters on zinc that were more than ordinarily detailed were issued in Mineral Resources for 1908, dealing largely with metallurgy; for 1915, dealing with the zinc deposits of the United States and foreign countries; and for 1918, dealing with the zinc industry in relation to the World War.

Primary zinc produced in the United States, 1918–1923, in short tons—Cont'd.

Apportioned according to locality at which reduced

	1918	1919	1920	1921	1922	1923
Arkansas	26, 753	31, 437	31, 481	15, 278	13, 627	29 870
Illinois	141, 844	118, 458	109, 056	48, 865	76, 266	93, 239
Kansas	29, 149	43, 942	41, 044	16, 573	24, 167	32, 006
Oklahoma	139, 066	121, 988	110, 500	41, 244	74, 537	119, 744
Pennsylvania	77, 342	67, 521	74, 234	36, 378	57, 319	82, 003
Other States	103, 773	82, 397	97, 062	42, 162	108, 361	153, 572
	517, 927	465, 743	463, 377	200, 500	354, 277	510, 434

DISTILLED AND ELECTROLYTIC ZINC

Selected secondary zinc materials, such as zinc ashes and scrap, carefully redistilled, yield zinc of all grades, which enters the market for practically all purposes. Considerable secondary material is mixed with ore and used by some regular ore smelters. The quantity of metal so derived can be calculated by the smelters and thus eliminated from the output of primary zinc, but it is practically impossible to segregate the redistilled secondary zinc by grades or in smelter stocks. Hence the smelter stocks as given contain some secondary zinc, and the statistics of production of zinc by grades as given in the table below likewise include secondary zinc. The quantity of secondary zinc included in the graded zinc is given in the first part of the table, which gives the source of the graded zinc by the methods of reduction.

Distilled and electrolytic zinc, primary and secondary, produced in the United States, 1918–1923, in short tons

Apportioned according to method of reduction

	1918	1919	1920	1921	1922	1923
Electrolytic	[a] 38, 916	27, 056	51, 626	11, 559	55, 369	71, 088
Distilled primary	479, 011	438, 687	411, 751	188, 941	298, 908	439, 346
Redistilled secondary zinc [b]	9, 918	19, 748	21, 371	17, 573	32, 988	39, 434
	527, 845	485, 491	484, 748	218, 073	387, 265	549, 868

Apportioned according to grade

Grade A (high grade)	129, 344	45, 377	80, 713	24, 084	67, 459	89, 739
Grade B (intermediate)	68, 987	39, 173	33, 893	4, 996	36, 402	58, 513
Grade C (select and brass special)	98, 584	140, 917	59, 811	47, 814	49, 980	90, 459
Grade D (prime western)	230, 930	260, 024	310, 331	141, 179	233, 424	311, 157
	527, 845	485, 491	484, 748	218, 073	387, 265	549, 868

[a] Prime western zinc refined by electrolysis in addition: In 1918, 753 tons.
[b] For total production of secondary zinc, see p. 82.

ROLLED ZINC

The table below includes the exports as shown by the records of the Bureau of Foreign and Domestic Commerce. If the figures showing the exports are deducted from those showing the production plus the imports, the result will approximate the quantity available for domestic consumption. The slab zinc rolled is included in the domestic output as given on a preceding page.

Zinc rolled in the United States, 1922 and 1923

	1922			1923		
	Pounds	Value		Pounds	Value	
		Total	Average		Total	Average
Sheet zinc not over 0.1 inch thick	50,203,438	$4,044,688	$0.081	49,179,501	$4,529,075	$0.092
Boiler plate and sheets over 0.1 inch thick	2,229,877	155,074	.070	2,294,230	186,415	.081
Strip and ribbon zinc	54,585,375	4,346,347	.080	60,192,743	5,449,491	.091
Total rolled zinc	107,018,690	8,546,109	.080	111,666,474	10,164,981	.091
Slab zinc, grades B and C [a]			.058			.068
Sheet zinc imported and entered for consumption	831,141	59,037	.071	584	41	.070
Rolled zinc exported	6,433,089	574,491	.089	7,463,362	764,369	.102
Available for consumption	101,416,742			104,203,696		

[a] The average price of the grades of zinc which are commonly rolled is given for comparison with the average price of rolled zinc.

The difference, or "spread," between the average price per pound of grades B and C zinc, which are those used in rolled zinc, and the average price per pound of zinc sheets is given in the foregoing table. During the later part of the World War the great demand for zinc sheets for packing munitions sent the price to a high figure, with a resulting wide difference between the price of sheets and of the metal, reaching over 6 cents a pound. During 1922 and 1923, however, the spread has been 2.2 and 2.3 cents, respectively.

ZINC DUST

The following table includes zinc dust made from both ores and secondary materials, as well as from slab zinc. To avoid duplication in the column giving "primary zinc recovered in zinc dust," all zinc in zinc dust made from slab zinc already counted in slab-zinc production is excluded. Statistics of the quantity of secondary zinc recovered as zinc dust are given in the table below headed "Secondary zinc." The output of "atomized" zinc dust as given in the table has been revised from previous years to take in a product not heretofore reported.

Zinc dust sold by producers in the United States, 1916–1923

Year	Prepared "blue powder"			Zinc dust "atomized"			Primary zinc recovered as zinc dust (short tons)
	Short tons	Value		Short tons	Value		
		Total	Average per pound		Total	Average per pound	
1916	2,548	$1,097,397	$0.215	234	$100,620	$0.215	2,293
1917	3,989	1,322,196	.166	2,134	712,922	.167	3,590
1918	4,016	877,171	.109	3,139	815,346	.130	4,166
1919	4,083	801,366	.098	2,715	566,294	.104	3,430
1920	9,066	2,009,117	.111	2,463	555,773	.113	6,425
1921	2,006	333,390	.083	999	152,151	.076	1,380
1922	3,394	531,225	.078	3,859	573,220	.074	2,113
1923	3,676	643,766	.088	4,376	702,923	.080	2,450

The average price of zinc dust, "blue powder," as calculated from sales during the year, was 8.8 cents a pound; "atomized" zinc dust brought 8 cents a pound. "Blue powder" brought a higher average price than "atomized" dust, because much of it was sold in the far West, where higher prices prevailed. The weekly fluctuation in the quoted price of zinc dust is shown in Figure 2 (p. 99).

The following operators reported the production of zinc dust in 1923:

Bartlesville Zinc Co., Bartlesville, Okla.
John Finn Metal Works, San Francisco, Calif.
Grasselli Chemical Co., Clarksburg, W. Va.
The Merrill Co., San Francisco, Calif.
Metals Disintegrating Co., Townley, N. J.
New Jersey Zinc Co., Palmerton, Pa.
United States Zinc Co., Sand Springs, Okla.
Wheeling Steel Corporation, Wheeling, W. Va.

ZINC PIGMENTS AND SALTS

Zinc forms the base, either in whole or in part, of four white pigments—zinc oxide, leaded zinc oxide, zinc-lead oxide, and lithopone. Two zinc salts, the chloride and the sulphate, are likewise made in part from ore and in part from secondary zinc. Details of the production of zinc pigments and salts and of market conditions are given in the chapter on lead and zinc pigments and salts.

The zinc content of the pigments and salts made in the United States from ore, both domestic and foreign, for the period 1918–1923, is given in the table below. Statistics of the secondary zinc recovered in the form of pigments and salts are given under the next heading.

Primary zinc content of zinc pigments and salts made in the United States, 1918–1923, in short tons

Year	Salts	Pigments	Year	Salts	Pigments
1918	(a)	102, 778	1921	3, 749	53, 480
1919	3, 393	96, 817	1922	1, 801	93, 112
1920	6, 284	110, 695	1923	1, 573	115, 970

[a] Figures not available.

SECONDARY ZINC[2]

Secondary zinc recovered in the United States, 1920–1923, in short tons

	1920	1921	1922	1923
Secondary zinc, redistilled	21, 371	17, 573	32, 988	39, 434
Secondary zinc, remelted	21, 479	16, 260	36, 326	25, 776
Recovered zinc in alloys, excluding old brass remelted	7, 650	5, 840	10, 250	8, 630
Recovered zinc in remelted brass	65, 000	38, 627	60, 280	65, 000
Secondary zinc recovered as metal	115, 500	78, 300	139, 844	138, 840
Secondary zinc recovered in zinc dust	1, 061	755	3, 405	3, 962
Secondary zinc recovered in pigments	12, 870	4, 024	8, 609	10, 322
Secondary zinc recovered in zinc salts	9, 479	10, 225	9, 016	10, 719
Total secondary zinc	139, 000	93, 000	161, 000	164, 000

[2] See page 79 for definition of secondary zinc.

BY-PRODUCT SULPHURIC ACID

An important by-product of zinc-smelting operations is the sulphuric acid made from the sulphur gases evolved in roasting the zinc sulphide ores preparatory to their distillation or conversion to zinc oxide or to zinc salts. Sulphur gases from zinc ores were first thus utilized by Matthiessen & Hegeler, at La Salle, Ill., in 1882, but now there are numerous acid plants using these gases. These acid plants may be located at zinc smelters and zinc-oxide plants, at roasting and magnetic separating plants, at the mines, or nearer the acid markets, the roasted concentrates being shipped to the smelters or to other zinc plants. Figures of output of this by-product acid for the period 1914–1920 were given in the chapter on zinc in Mineral Resources, 1920, and for 1921 in the chapter on zinc in Mineral Resources, 1922. Sulphuric acid statistics for 1923, collected by the Bureau of the Census, are not available at the time of preparation of this report.

MINE PRODUCTION

The preceding tables give the quantity of zinc recovered either as metal by smelting and by electrolytic reduction, or in zinc dust, or as zinc in pigments and salts. The following table shows the origin of the domestic zinc that is recovered by metallurgic operations. The origin of the zinc by States is obtained more accurately from the reports of mines, because smelters necessarily treat mixtures of ores, sometimes long after they have been received, so that the actual output of metallic zinc may not correspond at all closely to the product of the mines for the same year. The data for the tables of mine production are taken from the reports on gold, silver, copper, lead, and zinc in the different States.

Mine production of zinc in the United States, 1918–1923, in short tons

State	1918	1919	1920	1921	1922	1923
Arizona	1,135	859	729	----------	105	260
Arkansas	951	189	329	15	134	148
California	2,781	236	583	529	1,506	----------
Colorado	44,567	18,610	24,395	1,180	11,629	27,076
Idaho	22,581	7,997	13,966	17	2,055	13,976
Illinois	3,792	6,788	4,720	2,426	3,124	1,266
Kansas	30,197	47,636	61,073	36,994	56,225	100,969
Kentucky	315	36	9	220	142	270
Missouri	55,992	31,540	24,509	10,845	16,171	18,265
Montana	104,629	84,382	92,169	11,638	59,535	70,730
Nevada	8,362	4,502	5,349	35	1,309	7,083
New Hampshire	14	----------	----------	----------	----------	----------
New Jersey	[a] 102,318	[a] 92,516	[a] 78,511	56,447	73,657	75,227
New Mexico	12,025	3,797	5,007	114	2,248	8,248
New York	3,776	5,120	5,654	1,572	4,816	8,463
Oklahoma	161,401	178,410	219,727	121,372	209,682	242,421
Tennessee	21,071	23,247	19,217	9,692	15,568	15,900
Utah	9,200	2,216	4,079	35	2,560	5,665
Virginia	951	----------	----------	----------	----------	----------
Washington	19	----------	213	225	614	1,512
Wisconsin	50,014	40,765	27,285	3,390	10,952	13,211
	[a] 636,091	[a] 548,846	[a] 587,524	256,746	472,032	610,690

[a] The output of New Jersey for 1907–1920, inclusive, has been revised because of a misunderstanding which gave rise to slight but compensating error.

COMPARISON OF NEW YEAR ESTIMATES AND MINE AND SMELTER TOTALS OF DOMESTIC PRIMARY ZINC PRODUCTION

A paper presented at the annual meeting of the American Zinc Institute at St. Louis, April 28–29, 1924, by the senior author, was substantially as follows:

MINE PRODUCTION OF RECOVERABLE ZINC

The Geological Survey canvasses each producing zinc mine to ascertain its output of shipping ore and concentrate, together with the assay content, and from these returns is figured the total zinc content of the ores produced. Allowances are made for losses in transportation, concentrating, and smelting, and after deducting these allowances the remainder is set down as mine production of recoverable zinc—that is, zinc that should be recovered in smelters or other treatment plants. This detailed canvass is made as soon after the first of the year as practicable, but in order that the industry may have information to guide it between the first of the year and the date of the completion of the annual canvass, a special estimate of the output of the mines has for many years been made in December for use in a "New Year statement." The Joplin district publishes weekly sales of concentrates, and the Wisconsin district formerly published monthly statements, but for most of the country's output it is necessary to get individual figures from the larger producers and from these to estimate the total output. The Survey has offices at Denver, Salt Lake City, and San Francisco, and its representatives at these places watch current reports of shipments in the local news and also canvass the larger producers. The following table brings together these estimates and compares them with the final figures of mine production of zinc since 1911. It will be noted that the annual discrepancy in the New Year estimate varies from a small part of 1 per cent to a little over 6 per cent.

Mine production of recoverable zinc in the United States, 1911–1923

Year	New Year estimate (short tons)	Final figures (short tons)	Error in estimate	
			Short tons	Percentage
1911	348,000	[a] 331,515	+16,000	+4.8
1912	400,000	[a] 385,621	+14,000	+3.6
1913	414,000	[a] 413,824	+200	+.05
1914	[b]	[a] 415,774		
1915	560,000	[a] 588,060	−28,000	−4.8
1916	708,000	[a] 703,169	+5,000	+.7
1917	690,000	[a] 713,556	−24,000	−3.4
1918	627,000	[a] 636,091	−9,000	−1.4
1919	569,000	[a] 548,846	+20,000	+3.6
1920	597,000	[a] 587,524	+9,000	+1.5
1921	250,000	256,746	−7,000	−2.7
1922	442,000	472.032	−30.000	−6.4
1923	623,000	610,690	+12,000	+2.0

[a] Revised figures; see footnote, p. 83.
[b] No estimate.

SMELTER PRODUCTION OF PRIMARY SLAB ZINC

The Survey also makes a New Year canvass of the zinc smelters, as well as the regular canvass. The figures so obtained for 16 years are compared with the final figures in the table which follows. The New Year estimates are for some years too high and for others too low, but the variation from the final figures is small—never more than 5 per cent and approaching that in three years only. The preliminary figure in 1912 differed only 176 tons from the final figure, and in 1920 only 377 tons, and the general range of error has been below 2 per cent except in 1909, 1922, and 1923. In 1909 some of the regular smelters inadvertently included in their estimates considerable secondary zinc, which was eliminated from the final returns, thus making an overestimate of 4.9 per cent.

Slab zinc produced in the United States, 1908–1923

Year	New Year estimate (short tons)	Final figures (short tons)	Error in estimate	
			Short tons	Percentage
1908	208,000	210,424	−2,424	−1.2
1909	268,215	255,760	+12,455	+4.9
1910	267,423	269,184	−1,761	−.7
1911	288,044	286,526	+1,518	+.5
1912	338,630	338,806	−176	−.05
1913	345,575	346,676	−1,101	−.3
1914 [a]				
1915	488,122	489,519	−1,397	−.3
1916	658,488	668,343	−9,855	−1.5
1917	667,751	669,573	−1,822	−.3
1918	525,600	517,927	+7,673	+1.5
1919	459,000	465,743	−6,743	−1.4
1920	463,000	463,377	−377	−.08
1921	196,500	200,500	−4,000	−2.0
1922	339,000	354,277	−15,277	−4.3
1923	487,000	510,434	−23,434	−4.6

[a] New Year estimates refused by certain companies.

COMPARISON OF MINE AND SMELTER PRODUCTION OF DOMESTIC ZINC

In addition to canvassing the mines and zinc smelters the Survey also canvasses the zinc oxide works, the lithopone plants, and the zinc chemical works to ascertain their output and its composition, so that the total amount of zinc recovered from ore in all forms may be known. Care is taken not to duplicate by counting the zinc content of a product made from primary material already counted, such as French process zinc oxide made from slab zinc.

Both in the New Year canvass and in the regular canvass the smelters and other treatment plants are asked to distinguish in their returns the zinc made from ore from that made from secondary material, or if the charge is mixed to calculate from the composition of the material charged how much of the output was made from each class of material. The Survey wishes to know the total amount of new, primary, or virgin metal made or recovered each year for comparison with the computed recoverable zinc content of the ore produced. This comparison is made as a check on the accuracy of each canvass. Of course it is not expected that all the recoverable

zinc in the ore mined during any year will be recovered in smelting plants and chemical works that same year. There is always more or less lag; in some years more ore will be left in the bins at the end of the year than there was at the beginning of the year, and this will show as a mine excess—that is, more was mined than was treated; in other years the demand for the metal may exceed the rate of ore production, resulting in depletion of ore stocks, giving a smelter excess; but for a series of years these factors should balance. The following table balances the primary zinc recovered in all forms against the recoverable zinc content of ore mined in the 17 years 1907 to 1923, the whole period for which there are data. The total recoverable zinc for the 17 years was 7,777,346 tons, from which should be deducted the recoverable zinc content of domestic ore exported, 62,430 tons, leaving a remainder of 7,714,916 tons available for domestic recovery; the actual recovery was 7,573,561 tons of slab zinc and zinc in zinc dust, pigments, and salts. The whole of the recoverable zinc in the ore mined is thus accounted for except 141,355 tons, equal to 1.9 per cent of the total recovered zinc, which stands as a mine excess.

If the loss of zinc in smelting is underestimated, it results in an exaggerated figure for recoverable zinc, which will appear as a mine excess. But a mine excess may be due to other causes. Zinc smelters are now much larger than formerly, so that they must carry larger working ore stocks, and such increases in ore stocks appear as mine excess. The number and size of zinc oxide plants have also increased, and there have been corresponding increases in their ore stocks. Furthermore, part of the output of lithopone and zinc salts, all of which was formerly made from zinc ashes and other secondary materials, is now made from zinc ore, and this necessitates additional ore stocks. Considerable quantities of zinc salts were probably made from zinc ores before 1919, when statistical account was first taken of the output of the zinc so recovered. All these factors would tend to swell the apparent mine excess and are probably sufficient to account for the 1.9 per cent discrepancy. If they are, practically all the zinc recorded as mined since the beginning of 1907 has been recovered and accounted for in one form or another or is in stock in ore bins or in process at the reduction plants.

Domestic primary zinc balance sheet, 1907–1923

[Short tons]

Year	Recoverable zinc (mine production)			Recovered zinc (smelter production)			Mine excess (+) or smelter excess (−)
	Total	In exports of domestic zinc ores	Remainder available for domestic recovery	In slab zinc made from domestic ores	In pigments, salts, and zinc dust made from domestic ores	Total	
1907	[a] 253,017	8,141	244,876	223,745	56,931	280,676	−35,800
1908	[a] 234,064	10,443	223,621	190,749	47,281	238,030	−14,409
1909	[a] 302,373	4,982	297,391	230,225	52,948	283,173	+14,218
1910	[a] 324,444	7,884	316,560	252,479	50,660	303,139	+13,421
1911	[a] 331,515	7,312	324,203	271,621	43,408	315,029	+9,174
1912	[a] 385,621	9,340	376,281	323,907	62,876	386,783	−10,502
1913	[a] 413,824	7,085	406,739	337,252	71,037	408,289	−1,550
1914	[a] 415,774	4,444	411,330	343,418	81,254	424,672	−13,342
1915	[a] 588,060	333	587,727	458,135	80,939	539,074	+48,653
1916	[a] 703,169	31	703,138	564,338	92,537	656,875	+46,263
1917	[a] 713,556	528	713,028	584,597	100,275	684,872	+28,156
1918	[a] 636,091	25	636,066	492,405	105,342	597,747	+38,319
1919	[a] 548,846		548,846	452,272	101,561	553,833	−4,987
1920	[a] 587,524		587,524	450,045	118,966	569,011	+18,513
1921	256,746		256,746	198,232	57,216	255,448	+1,298
1922	472,032	678	471,354	353,274	95,788	449,062	+22,292
1923	610,690	[b] 1,204	609,486	508,335	119,513	627,848	−18,362
	7,777,346	62,430	7,714,916	6,235,029	1,338,532	7,573,561	+141,355=1.9%

[a] Revised figures; see footnote, p. 83.

[b] The Bureau of Foreign and Domestic Commerce in 1923 did not distinguish exports of zinc in ore from exports of zinc dross and old zinc. The exports of zinc in ore for that year have been obtained from the Canadian smelter.

ZINC-REDUCTION PLANTS

Zinc-smelting plants operating in the United States in 1923

Operating company (A=acid plant; not necessarily at the smelter)	Location of plant	Retorts
ARKANSAS		
Athletic Mining & Smelting Co	Fort Smith	3,328
Falcon Zinc Co	Van Buren	3,200
Fort Smith Spelter Co	Fort Smith	2,560
ILLINOIS		
American Zinc Co. of Illinois (A)	Hillsboro	4,864
Do. (A)	East St. Louis	5,620
Eagle-Picher Lead Co. (A)	Hillsboro	3,200
Hegeler Zinc Co. (A)	Danville	5,400
Illinois Zinc Co. (A)	Peru	5,568
Matthiessen & Hegeler Zinc Co. (A)	La Salle	6,132
Mineral Point Zinc Co. (A)	Depue	9,068
Missouri Zinc Co	Beckemeyer	500
Sandoval Zinc Co	Sandoval	896
INDIANA		
Grasselli Chemical Co	Terre Haute	4,200
KANSAS		
Edgar Zinc Co	Cherryvale	5,040
Weir Smelting Co	Caney	1,920

Zinc-smelting plants operating in the United States in 1923—Continued

Operating company (A=acid plant; not necessarily at the smelter)	Location of plant	Retorts
OKLAHOMA		
Bartlesville Zinc Co	Bartlesville	5,184
Blackwell Zinc Co. (Inc)	Blackwell	9,600
Eagle-Picher Lead Co	Henryetta	4,800
National Zinc Co	Bartlesville	4,256
Quinton Spelter Co	Quinton	2,016
Tulsa Fuel & Manufacturing Co	Collinsville	5,432
United States Zinc Co	Kusa	3,760
Do	Henryetta	3,200
PENNSYLVANIA		
American Steel & Wire Co. (A)	Donora	8,512
American Zinc & Chemical Co. (A)	Langeloth	5,168
New Jersey Zinc Co. (of Pennsylvania) (A)	Palmerton	7,200
TEXAS		
United States Zinc Co	Amarillo	3,200
WEST VIRGINIA		
Grasselli Chemical Co	Clarksburg	5,760
Do	Meadowbrook	8,400
United Zinc Smelting Corporation	Moundsville	2,368
		140,352

NOTE.—The Grasselli Chemical Co. operates acid plants in connection with its zinc-roasting furnaces at Grasselli, Ind.; Cleveland, Canton, and Lockland (near Cincinnati), Ohio; and New Castle, Pa., and smelts the roasted zinc concentrates at the smelters at Terre Haute, Ind., and Clarksburg and Meadowbrook, W. Va. The Bertha Mineral Co. operates roasting furnaces and an acid plant at Tiltonsville, Ohio. The National Zinc Co. has roasting furnaces and an acid plant at Argentine, Kans. The American Zinc Oxide Co., Columbus, Ohio, has installed a zinc-roasting plant and disposes of the sulphur gases to the neighboring acid plant of the Farmers' Fertilizer Co.

The number of retorts at zinc smelters at the end of 1923 was 140,352 at 30 plants that had operated sometime during the year. The number of retorts in operation at the end of the year was 86,670 at 28 plants, compared with 81,030 in operation at 26 plants at the end of 1922. The plants of the Eagle-Picher Lead Co., Hillsboro, Ill., and Sandoval Zinc Co., Sandoval, Ill., were not in operation at the end of the year.

In addition to the regular retort smelters the Anaconda Copper Mining Co. operated its electrolytic zinc plant at Great Falls, Mont.

The following operators treated secondary materials in large graphite retorts during the year:

General Smelting Co., Philadelphia, Pa.
Tottenville Copper Co., Tottenville, N. Y.
Trenton Smelting & Refining Co., Trenton, N. J.
Wheeling Steel Corporation, Wheeling, W. Va.
Youngstown Sheet & Tube Co., Youngstown, Ohio.

The United States Zinc Co. began operations at its plant at Amarillo, Tex., in May, 1923. The fifth block of 800 retorts was under construction at the end of the year.

The Eagle-Picher Lead Co. added a block of 800 retorts at its plant at Henryetta, Okla.

The American Smelting & Refining Co. decided upon the erection of a zinc smelter of two blocks of furnaces, including 1,600 retorts at Rosita, Coahuila, Mexico, in connection with the by-product coke plant. A 30-ton acid plant will be operated, and ammonium sulphate will be made.

TRADE CONDITIONS

WORLD'S PRODUCTION

In the following table, prepared by W. I. Whiteside, of the United States Geological Survey, the figures in black-faced type are taken from the official statistics of the countries named; those in ordinary type for Austria, China, Czechoslovakia, and Yugoslavia are the figures of Rudolph Wolff & Co., of London; other figures in ordinary type are taken from the 1923 yearbook of the American Bureau of Metal Statistics, an association of the copper producers, the lead producers, and the principal zinc producers of this country. The official statistics will be substituted in this record as fast as they are made available.

There is always a possibility of duplication in figures showing European production, for some countries send crude zinc of poor quality to other countries for refining. Furthermore, secondary zinc is included in the figures showing the foreign production, so that to put the United States on an equal footing in the statistics it would be necessary to include in the statement of its production figures for the domestic output of secondary zinc.

World's smelter production of zinc, 1913 and 1918–1923, in metric tons, by countries where smelted

Country	1913	1918	1919	1920	1921	1922	1923
Australia:							
New South Wales	**4,187**	**5,712**	**3,625**	**4,136**			
Tasmania		**3,883**	**3,727**	**5,902**	**1,136**	**23,894**	**41,814**
Austria	[a] **19,508**	[a] 12,000			240	250	
Belgium	**204,220**	**9,245**	**19,860**	**84,260**	**66,150**	**112,290**	**148,080**
Canada		**11,139**	**11,182**	**16,798**	**24,035**	**25,533**	**27,238**
China	(*b*)	(*b*)	(*b*)	180	1,290	406	508
Czechoslovakia	(*c*)	(*c*)	2,091	4,267	6,706	2,337	4,877
France	**67,890**	**18,347**	**10,800**	**20,085**	**24,168**	**39,716**	43,850
Germany:							
Upper Silesia	**169,439**	**122,961**	**74,023**	**81,482**	**62,930**	[d] **36,615**	(*e*)
Other Germany	**109,420**	**62,212**	**23,381**	**16,494**	27,070	43,385	48,000
Great Britain	66,243	39,001	38,227	25,000	5,910	18,624	31,782
Italy		**1,188**	**1,282**	**1,177**	**527**	**3,082**	**3,601**
Japan	900	**39,915**	**19,816**	**15,745**	**10,374**	**12,371**	**14,000**
Netherlands	**24,323**	**681**		**2,031**	**6,405**	**12,997**	**16,440**
Norway	9,287	1,855	3,386	1,837	2,000	1,850	2,000
Poland:							
Upper Silesia	(*f*)	(*f*)	(*f*)	(*f*)	(*f*)	[g] **42,275**	84,000
Other Poland	(*h*)	(*h*)	**4,652**	**5,361**	**5,000**	**9,126**	10,638
Russia	**10,500**	4,893	(*b*)	(*b*)	(*b*)	118	(*b*)
Spain	**6,003**	**15,900**	**16,314**	**9,647**	**6,738**	**6,269**	**10,922**
Sweden	**2,115**	**4,098**	**2,321**	**5,759**	**3,510**	**1,550**	1,400
United States	**314,498**	**469,853**	**422,513**	**420,366**	**181,890**	**321,393**	**463,056**
Yugoslavia	(*c*)	(*c*)	**1,919**	**1,511**	**420**	**1,056**	2,439
Known production	1,008,500	823,000	659,000	722,000	436,000	715,000	955,000

[a] Represents old Austrian Empire and includes territories now included under Czechoslovakia and Yugoslavia. [b] Data not available. [c] Included under Austria. [d] First six months; for second six months see Poland. [e] See Poland. [f] See Germany. [g] Second six months; for first six months see Germany. [h] Included under Russia.

The following table, also prepared by W. I. Whiteside, shows the output of zinc ore by different countries in the years 1919–1923, inclusive. Official reports for 1923 were almost altogether lacking at the time the table was prepared. The zinc content is estimated where possible, but many official reports give no information on which such an estimate could be based.

World's mine production of zinc ore and concentrates, with estimated zinc content, 1919–1923, in metric tons

Country.	1919		1920		1921		1922		1923	
	Ore	Zinc content	Ore	Zinc content	Ore	Zinc content	Ore	Zinc content	Ore	Zinc content
North America:										
Canada	122,955	27,197	226,011	41,292	269,801	44,814	(a)	(a)	(a)	(a)
Mexico (imports into United States)	30,339	10,183	43,048	13,585	5,488	1,948	(a)	1,510	(a)	1,210
United States (recoverable zinc)	(a)	497,902	(a)	532,990	(a)	232,915	(a)	428,218	(a)	554,006
South America:										
Bolivia (exports)	1,902	(a)	1,206	(a)					390	(a)
Europe:										
Austria [b]	698	254	605	570	554	141	80	32	(a)	1,013
Belgium	(a)	(a)	(a)	(a)	(a)	(a)	26	(a)	(a)	(a)
Bulgaria	(a)	(a)	(a)	(a)	(a)	(a)	75	(a)	(a)	(a)
Czechoslovakia	315	(a)	2,077	(a)	1,781	(a)	3,116	(a)	(a)	(a)
Finland	(a)	(a)	9,180	(a)	(a)	(a)	(a)	(a)	(a)	(a)
France	24,297	16,400	23,505	11,000	16,249	7,500	4,660	2,000	10,940	5,000
Germany—										
Upper Silesia	218,487	82,704	243,308	92,257	217,921	(a)	(c)	(c)	(c)	(c)
Other Germany	66,538	30,381	48,147	21,733	79,193	(a)	(a)	(a)	(a)	(a)
Greece—										
Zinc ore	3,334	(a)	2,591	(a)	1,920	(a)	1,149	(a)	4,026	(a)
Zinc-lead ore	2,493	(a)	2,636	(a)	858	(a)	132	(a)	314	(a)
Italy—										
Zinc ore	65,629	26,901	95,985	41,000	69,000	29,000	82,266	35,000	132,596	52,000
Zinc-lead-copper ore	3,915	560	570	60	840	80	430	40	1,711	300
Norway	337	(a)	148	(a)	7	(a)	552	(a)	(a)	(a)
Poland—										
Upper Silesia	(d)	(d)	(d)	(d)	(d)	(d)	227,881	(a)	(a)	(a)
Other Poland	67,645	(a)	64,354	(a)	58,824	(a)	66,400	(a)	(a)	(a)
Russia	(a)	(a)	(a)	(a)	3,767	(a)	795	(a)	(a)	(a)
Spain	103,608	29,902	94,095	28,250	48,357	17,446	71,996	23,954	102,313	(a)
Sweden	49,451	17,446	47,674	16,609	29,426	11,025	38,023	14,186	(a)	(a)
United Kingdom	7,044	2,475	5,145	1,682	827	297	1,646	590	2,158	959
Yugoslavia	90	(a)	278	(a)	126	(a)	288	(a)	618	(a)
Asia:										
China (exports)	2	(a)	9,116	(a)	11,928	(a)	(a)	(a)	(a)	(a)
Chosen	3,212	(a)	3,483	(a)	141	(a)			(a)	(a)
India, British	(a)	(a)	(a)	(a)	4,064	(a)	18,351	(a)	(a)	(a)
Indo China	15,934	7,648	7,198	3,455	11,035	5,297	20,936	9,421	30,500	12,800
Japan	495,705	(a)	702,985	(a)	24,707	(a)	(a)	(a)	(a)	(a)
Turkey	(a)	(a)	1,514	(a)	(a)	(a)	(a)	(a)	(a)	(a)

Africa:										
Algeria	13,293	5,583	26,562	11,156	14,550	6,693	31,439	13,500	47,773	19,500
Rhodesia, Northern					18	(a)	3	(a)	44	(a)
Tunis	40,253	16,101	12,575	5,030	4,541	1,816	8,868	3,547	12,000	4,800
Union of South Africa			2,131	(a)	1,161	(a)			(a)	
Oceania:										
Australia	73,454	35,000	72,183	35,000	80,973	39,000	365,518	172,000	432,887	(a) 195,000

[a] Data not available.
[b] Data represent zinc ore only; lead-zinc ores not included.
[c] Data for German Upper Silesia not available; for Polish Upper Silesia, see Poland.
[d] See Germany.

IMPORTS AND EXPORTS

The following tables of imports and exports of zinc and of zinc remaining in warehouses have been compiled from the publications and records of the Bureau of Foreign and Domestic Commerce of the Department of Commerce by J. A. Dorsey, of the United States Geological Survey.

Zinc remaining in warehouse in the United States, December 31, 1918–1923

Year	Ore and calamine		Blocks, pigs, and old		Zinc dust	
	Zinc content (pounds)	Value	Pounds	Value	Pounds	Value
1918	53,766,247	$1,089,560				
1919	37,696,007	674,384				
1920	51,299,109	996,386				
1921	28,583,018	647,654	262,221	$10,911		
1922			160,976	6,396		
1923	1,736,874	84,977	160,976	6,396	[a] 2,048	[a] $256

[a] Includes manufactures of zinc.

Zinc imported for consumption in the United States, 1918–1923

Year	Blocks or pigs		Sheets		Old		Zinc dust		Value of manufactures	Total value
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value		
1918	11	$2,897	(a)	$29	24	$2,056	16	$3,552	$331	$8,865
1919	32	2,284	1	249	37	2,216	52	5,753	1,258	11,760
1920	(a)	17	4	614	14	1,065	17	6,207	1,746	9,649
1921	6,598	559,870	6,688	496,445	6	341	42	1,121	8,290	1,066,067
1922	40	3,327	416	59,037	46	2,403	79	5,614	9,517	79,898
1923	1	375	(a)	41	20	1,624	4	891	16,331	19,262

[a] Less than a ton.

General imports into the United States of old brass fit only for remanufacture, 1918–1923

[Average composition about one-third zinc and two-thirds copper]

Year	Short tons	Value	Year	Short tons	Value
1918	6,115	$1,774,002	1921	20,449	$2,373,082
1919	7,938	2,157,948	1922	71,962	10,985,308
1920	22,355	5,174,885	1923	20,395	3,992,917

No American zinc was returned from abroad in 1922 or 1923. The quantities so returned in the period September, 1920, to March, 1921, are given by months in the chapter on zinc in Mineral Resources, 1921. The tariff of 1922 has a paragraph on the return of United States products, which provides that to be admitted free of duty they must be imported by or for the account of the person who exported them from the United States.

General imports of zinc ore into the United States, 1904–1923, in short tons

Year	Canada		Mexico		Other countries		Total	
	Ore	Zinc content [a]	Ore	Zinc content [a]	Ore	Zinc content	Ore	Zinc content [a]
1904			2,264	[a] 801			2,264	[a] 801
1905	4,063	[a] 1,650	18,074	[a] 6,398			22,137	[a] 8,048
1906	423	[a] 172	54,991	[a] 19,467			55,414	[a] 19,639
1907	1,112	[a] 451	102,005	[a] 36,110			103,117	[a] 36,561
1908	7,406	[a] 3,007	46,351	[a] 16,408			53,757	[a] 19,415
1909	10,024	[a] 4,070	104,826	[a] 37,108			114,850	[a] 41,178
1910	4,749	1,922	67,877	23,517			72,626	25,439
1911	2,359	947	36,757	14,986			39,116	15,933
1912	8,015	3,661	35,925	13,606			43,940	17,267
1913	8,899	3,498	17,476	6,160	5,041	3,839	31,416	13,497
1914	11,250	4,467	20,705	7,663	7	2	31,962	12,132
1915	11,992	4,710	57,699	17,804	89,161	35,155	158,852	57,669
1916	21,908	8,790	161,271	51,028	202,785	88,329	385,964	148,147
1917	16,559	5,155	145,358	45,697	49,678	21,622	211,595	72,474
1918	14,987	5,173	53,348	18,426	2,567	1,210	70,902	24,809
1919	10,656	3,878	33,443	11,225	4,550	1,906	48,649	17,009
1920	4,731	1,794	47,453	14,975	13,589	5,718	65,773	22,487
1921	1,471	554	6,050	2,147	18	4	7,539	2,705
1922	[b]	235	[b]	1,665	[b]	29	[b]	1,929
1923	[b]	4	[b]	3,201	[b]	18	[b]	3,223

[a] Zinc content estimated for years prior to 1910 on basis of zinc content of ore from Mexico and Canada for 1910–1915.
[b] Gross weight not recorded.

The sources of the zinc ore imported from "Other countries" in 1915–1918 are given in the chapter on zinc in Mineral Resources, 1918, Part I, page 1066, and of that imported in 1919–1920, in the chapter in Mineral Resources, 1920, Part I, page 232.

Domestic zinc ore and domestic manufactures of zinc exported from the United States, 1918–1923

Year	Zinc ore		Pigs or slabs		Plates and sheets		Zinc dross		Zinc dust	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1918	62	$2,480	66,369	$12,469,622	13,875	$4,566,756	15,816	$2,238,913	[a]	[a]
1919	109,746	17,524,153	19,762	5,212,002	5,123	739,295	[a]	[a]		
1920	74,046	12,495,144	11,852	2,832,993	2,445	316,637	[a]	[a]		
1921	1,753	204,984	1,816	425,618	510	45,340	[a]	[a]		
1922	1,695	33,592	26,815	2,994,625	3,217	574,491	8,412	662,080	1,998	$287,890
1923	[b] 2,804	[b]	42,131	5,961,525	3,732	764,369	[c] 14,745	[c] 1,221,986	3,679	507,289

[a] Quantity and value not available prior to 1922.
[b] Not separately enumerated in 1923, but included under "Zinc dross"; Canadian smelters report imports of 2,804 tons of zinc ore and concentrates from the United States.
[c] Exports of zinc ore and dross are lumped together, these figures include the quantity and value of zinc ore exported as shown in the first column.

Domestic brass and brass manufactures exported from the United States, 1918–1923

[Zinc content approximately 30 per cent by weight]

Year	Bars, plates, and sheets		Scrap and old		Articles made from brass	Total value
	Short tons	Value	Short tons	Value		
1918	15,495	$9,522,934	2,455	$799,318	$19,483,146	$29,805,398
1919	3,885	2,310,561	661	176,028	11,426,289	13,912,878
1920	2,905	1,671,608	1,030	254,189	13,202,854	15,128,651
1921	1,437	741,110	2,969	405,871	7,123,366	8,270,347
1922	1,830	635,449	3,147	514,322	7,675,979	8,825,750
1923	1,733	703,503	6,587	1,198,560	6,917,901	8,819,964

Foreign zinc exported from the United States in 1918–1923

Year	Exported from warehouse			Exported in manufactures with benefit of drawback, slabs and sheets excluded (short tons)
	Blocks, pigs, and old		All other manufactures	
	Short tons	Value		
1918	20,069	$3,565,127		6,337
1919	12,256	1,943,507	$13,071	4,533
1920	28,132	4,331,636		237
1921	1,256	100,677	10,785	130
1922	3,471	429,122	30,227	1,298
1923	7,080	941,257	(a)	

a Not given separately.

Domestic and foreign zinc exported from the United States, 1922 and 1923, by destinations

[Figures in parentheses are not duplicated in the totals]

Destination	Domestic				Foreign (slabs)	
	Slabs		Sheets			
	Short tons	Value	Short tons	Value	Short tons	Value
1922						
Africa			3	$727		
Asia	7,487	$805,748	322	46,456	224	$22,175
China	(1,323)	(155,849)	(11)	(3,697)		
Japan	(6,060)	(638,867)	(255)	(31,289)	(224)	(22,175)
Philippine Islands	(a)	(532)	(44)	(8,131)		
Australia and Oceania			54	17,163		
Canada	464	52,674	1,282	202,149	50	5,950
Cuba	(a)	34	149	25,560		
Europe	18,202	2,058,902	757	163,335	3,044	381,231
Belgium	(1,834)	(240,758)	(56)	(6,158)		
France	(8,282)	(938,978)	(75)	(13,674)	(784)	(82,306)
Great Britain	(7,342)	(793,207)	(593)	(133,405)	(2,021)	(274,335)
Italy	(319)	(33,101)	(2)	(690)	(196)	(19,665)
Spain	(128)	(14,415)	(5)	(1,495)	(43)	(4,925)
Mexico	415	49,685	375	58,977	119	15,845
Panama			9	1,666		
South America	234	26,373	142	35,768	34	3,921
Argentina	(174)	(19,034)	(29)	(7,024)		
Brazil	(45)	(5,359)	(45)	(12,811)	(34)	(3,763)
Chile	(15)	(1,923)	(7)	(2,009)		
Colombia	(a)	(13)	(33)	(6,406)		
Ecuador			(2)	(453)	(a)	(158)
Peru	(a)	(44)	(14)	(3,633)		
Other countries	13	1,209	124	22,690		
	26,815	2,994,625	3,217	574,491	3,471	429,122
1923						
Africa			4	817		
Asia	72	10,817	285	57,538	6	966
China			(73)	(13,935)	(6)	(966)
Japan	(1)	(253)	(131)	(25,804)		
Philippine Islands			(67)	(13,366)		
Australia and Oceania	10	2,134	67	23,622		
Canada	326	56,007	908	170,341	(a)	105
Cuba	3	583	323	63,883		
Europe	41,438	5,848,293	1,010	225,960	7,069	939,383
Belgium	(1,008)	(156,129)	(a)	(59)		
France	(5,117)	(747,079)	(136)	(26,751)	(1,064)	(144,939)
Great Britain	(31,694)	(4,427,563)	(709)	(167,622)	(5,893)	(780,459)
Italy	(1,171)	(169,197)	(113)	(14,462)	(112)	(13,985)
Spain	(174)	(26,655)	(15)	(5,150)		
Mexico	189	28,400	480	90,783	4	719

a Less than 1 ton.

Domestic and foreign zinc exported from the United States, 1922 and 1923, by destinations—Continued

Destination	Domestic				Foreign (slabs)	
	Slabs		Sheets			
	Short tons	Value	Short tons	Value	Short tons	Value
1923						
Panama	3	$483	28	$5,318		
South America	86	14,125	375	78,917	1	$84
Argentina	(55)	(8,961)	(89)	(19,505)		
Brazil	(6)	(1,039)	(135)	(26,010)		
Chile	(25)	(3,943)	(11)	(2,413)		
Colombia	(a)	(87)	(87)	(16,402)		
Ecuador			(13)	(3,262)		
Peru	(a)	(67)	(21)	(6,339)	(1)	(84)
Other countries	4	683	252	47,190		
	42,131	5,961,525	3,732	764,369	7,080	941,257

[a] Less than 1 ton.

CUSTOMS DUTIES ON ZINC

In the chapter on zinc in Mineral Resources for 1922, pages 48–49, there was a comparison of duties on zinc in ore and as metal imposed in the tariff acts of 1909, 1912, and 1922. The tariff act of 1922 contains the following paragraphs relating to zinc ore and zinc in metallic forms:

PAR. 394. Zinc-bearing ore of all kinds, containing less than 10 per centum of zinc, shall be admitted free of duty; containing 10 per centum or more of zinc and less than 20 per centum, one-half of 1 cent per pound on the zinc contained therein; containing 20 per centum or more of zinc and less than 25 per centum, 1 cent per pound on the zinc contained therein; containing 25 per centum of zinc, or more, 1½ cents per pound on the zinc contained therein: Provided, That on all importations of zinc-bearing ores the duties shall be estimated at the port of entry, and a bond given in double the amount of such estimated duties for the transportation of the ores by common carriers bonded for the transportation of appraised or unappraised merchandise to properly equipped sampling or smelting establishments, whether designated as bonded warehouses or otherwise. On the arrival of the ores at such establishments they shall be sampled according to commercial methods under the supervision of Government officers, who shall be stationed at such establishments, and who shall submit the samples thus obtained to a Government assayer, designated by the Secretary of the Treasury, who shall make a proper assay of the sample and report the result to the proper customs officers, and the import entries shall be liquidated thereon. And the Secretary of the Treasury is authorized to make all necessary regulations to enforce the provisions of this paragraph.

PAR. 395. Zinc in blocks, pigs, or slabs, and zinc dust, 1¾ cents per pound; in sheets, 2 cents per pound; in sheets coated or plated with nickel or other metal (except gold, silver, or platinum), or solutions, 2¼ cents per pound; old and worn-out, fit only to be remanufactured, 1½ cents per pound.

CONSUMPTION

APPARENT CONSUMPTION OF PRIMARY SLAB ZINC

Primary zinc consumed in the United States, 1918–1923, in short tons

	1918	1919	1920	1921	1922	1923
Supply:						
Stock Jan. 1—						
In bonded warehouses	32				131	80
At smelters	53,689	41,241	36,793	71,037	70,321	16,810
Production	517,927	465,743	463,377	200,500	354,277	510,434
Imports, foreign	35	70	15	6,739	52	21
Imports, domestic, returned			8,162	731		
Total available	571,683	507,054	508,347	279,007	424,781	527,345
Withdrawn:						
Exports, foreign, from warehouse	20,069	12,256	28,132	1,256	3,471	7,080
Exports, foreign, under drawback	6,337	4,533	237	130	1,298	
Exports, domestic	80,244	129,508	85,898	3,569	30,032	45,863
Stock Dec. 31—						
In bonded warehouses				131	80	80
At smelters	41,241	36,793	71,037	70,321	16,810	27,808
Total withdrawn	147,891	183,090	185,304	75,407	51,691	80,831
Apparent consumption	423,792	323,964	323,043	203,600	373,090	446,514

CONSUMPTION OF SLAB ZINC IN HOT GALVANIZING

Statistics of the output, by the hot process, of galvanized sheets, galvanized formed products made from iron or steel sheets, and galvanized wrought-iron and steel pipe are gathered by the American Iron and Steel Institute from all the manufacturers of these products and are published yearly. Other classes of galvanized products, such as wire, barbed wire, cast and forged products, and nails, spikes, and bolts are not taken into statistical account by the Institute. As described on pages 1071–1072 of Mineral Resources for 1918, Part I, a fairly close estimate can be formed of the quantity of zinc used in coating these reported products, and, though it represents only a part of the total zinc consumed in galvanizing, a comparison of the yearly figures gives a good idea of the relative condition of the galvanizing industry. On this basis the estimated consumption of zinc in galvanizing in 1923 was nearly 40 per cent in excess of the quantity used in 1913 and 1914, as shown in Mineral Resources for 1915, Part I, and 90 per cent larger than the consumption in 1918. Statistics of the zinc used in galvanizing wire collected by the Bureau of the Census for 1919 were given as 25,850 tons; figures for later years have not been collected. Statistics for the principal other galvanized products are given in the following table:

Galvanized sheets, pipe, etc., produced in the United States and zinc used in galvanizing them, 1918-1923, in short tons

	1918	1919	1920	1921	1922	1923
Galvanized iron and steel sheets [a]	579,889	750,288	935,680	683,442	1,054,996	1,182,431
Galvanized formed products [a] [b]	60,555	70,247	71,947	54,978	82,857	82,871
Galvanized pipe [a]	296,444	300,335	355,397	299,106	436,957	512,865
	936,888	1,120,870	1,363,024	1,037,526	1,574,810	1,778,167
Zinc used (estimated)	112,500	134,500	163,500	124,500	189,000	213,000

[a] From annual statistical reports of American Iron and Steel Institute.
[b] Articles formed or stamped from iron or steel sheets and galvanized after shaping.

CONSUMPTION OF SLAB ZINC BY USES

The largest use of slab zinc is in galvanizing, but another large use is in making brass, and a considerable quantity is rolled into sheet zinc. For a number of years the quantity of slab zinc thus consumed has been estimated by W. R. Ingalls, formerly in the Engineering and Mining Journal and recently in the Yearbook of the American Bureau of Metal Statistics. The estimates for a few typical years are given below.

Estimated consumption of slab zinc in the United States by uses, 1908-1910, 1916-1917, 1919-1923, in short tons

	Galvanizing	Brass-making	Sheet zinc	Other purposes[a]	Total
1908	119,000	33,000	27,000	12,500	191,500
1909	164,000	48,000	33,000	16,600	261,600
1910	162,000	54,000	29,700	24,300	270,000
1916	200,000	175,000	47,500	27,800	450,300
1917	190,000	170,000	57,000	28,000	445,000
1919	163,000	155,000	55,000	29,000	402,000
1920	192,000	144,000	53,200	35,000	424,200
1921	138,100	75,000	30,400	19,000	262,500
1922	205,400	145,000	53,500	36,000	439,900
1923	233,800	175,000	55,800	49,000	513,600

[a] Includes zinc used for the manufacture of French oxide, lithopone, atomized zinc dust, die castings, slush castings, and for the desilverization of lead.

PRICES AND VALUE

The fluctuations in the quoted price of the prime western grade of zinc at St. Louis are illustrated in Figure 1, which shows graphically for the year 1923 the relations of the average weekly St. Louis quoted price of zinc, the weekly average London price of zinc, the weekly average price of 60 per cent zinc blende concentrates at Joplin, Mo., and the weekly sales of concentrates in the Joplin region as a whole. The price of zinc has been taken from market reports; the price of zinc blende and the figures of weekly sales are those published in the Joplin daily papers. To eliminate the sharp weekly fluctuations and to obtain a curve more easily comparable with the price curves, the weekly sales have been averaged by months, the result being shown by the broken line.

The price of prime western zinc at the beginning of the year in the St. Louis market was 7.05 cents, and after declining a little it rose in March to 8 cents. A decline through the next quarter carried the price down at the end of June to 5.77½ cents. By September it rose to 6.55 cents, and at the end of the year zinc was selling at about 6.25 cents. The average quoted price a pound for prime western zinc for immediate delivery at St. Louis in 1923 was slightly under 6.7 cents, as compared with 5.7 cents in 1922, and with 4.7 cents in 1921.

The London average quotation for the year was £26 16s. 4d. per long ton, as compared with £29 14s. 2d. in 1922, as shown in "Metal statistics, 1924," published by the American Metal Market Co., of New York.

A canvass of the sales of zinc and the prices received in 1923 gives 6.8 cents a pound as the average selling price of all grades. The average selling price for all grades is the price used in calculating the value of the zinc output of the country.

Price of zinc, by grades, 1918-1923, in cents per pound

[Average price received except as otherwise stated]

	1918	1919	1920	1921	1922	1923
Grade A (high grade)	11.1	8.3	8.4	5.6	6.0	7.1
Grade B (intermediate)	10.7	7.7	8.3	5.5	6.0	7.1
Grade C (select and brass special)	8.0	7.2	8.2	4.9	5.6	6.7
Grade D (prime western)	7.9	7.1	8.0	4.9	5.6	6.7
All grades	9.1	7.3	8.1	5.0	5.7	6.8
Prime western, average spot quotation at St. Louis	8.0	7.0	7.8	4.7	5.7	6.7

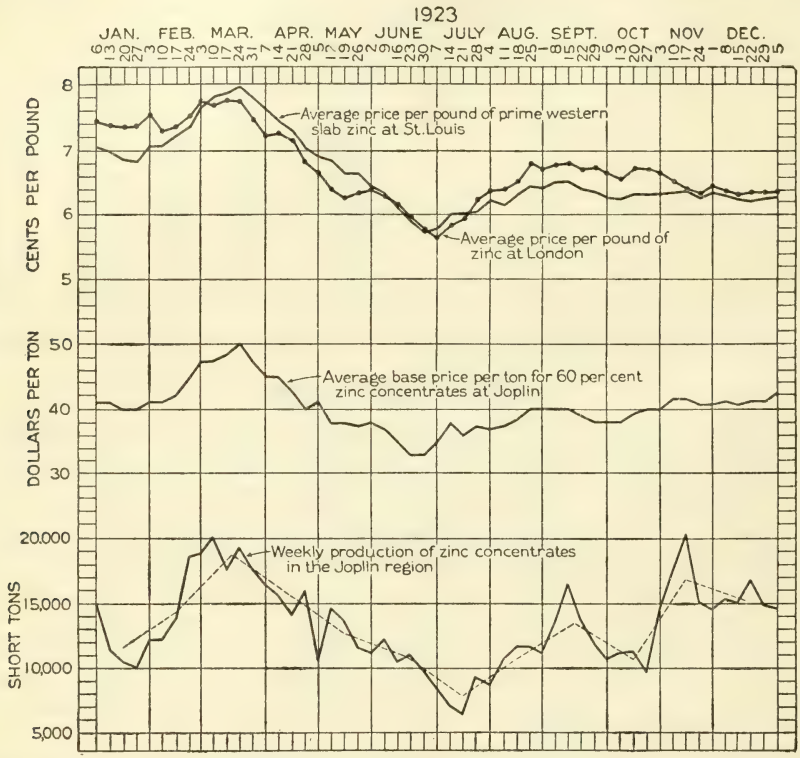

FIGURE 1.—Average weekly quoted price of zinc at St. Louis and London and of 60 per cent zinc concentrates at Joplin and weekly "production" (sales) of zinc concentrates in the Joplin region, 1923.

Figure 2 shows graphically the average of weekly quotations for prime western slab zinc for prompt delivery at St. Louis and on the same vertical scale the weekly quotations on zinc sheets and zinc dust. The curve for slab zinc is irregular and shows quotations varying daily, but the curves showing quotations on zinc sheets and zinc dust are horizontal for weeks at a time. It should be borne in mind, however, that the quotations on zinc sheets are subject to discounts and that the discounts may fluctuate while the base quotation remains steady.

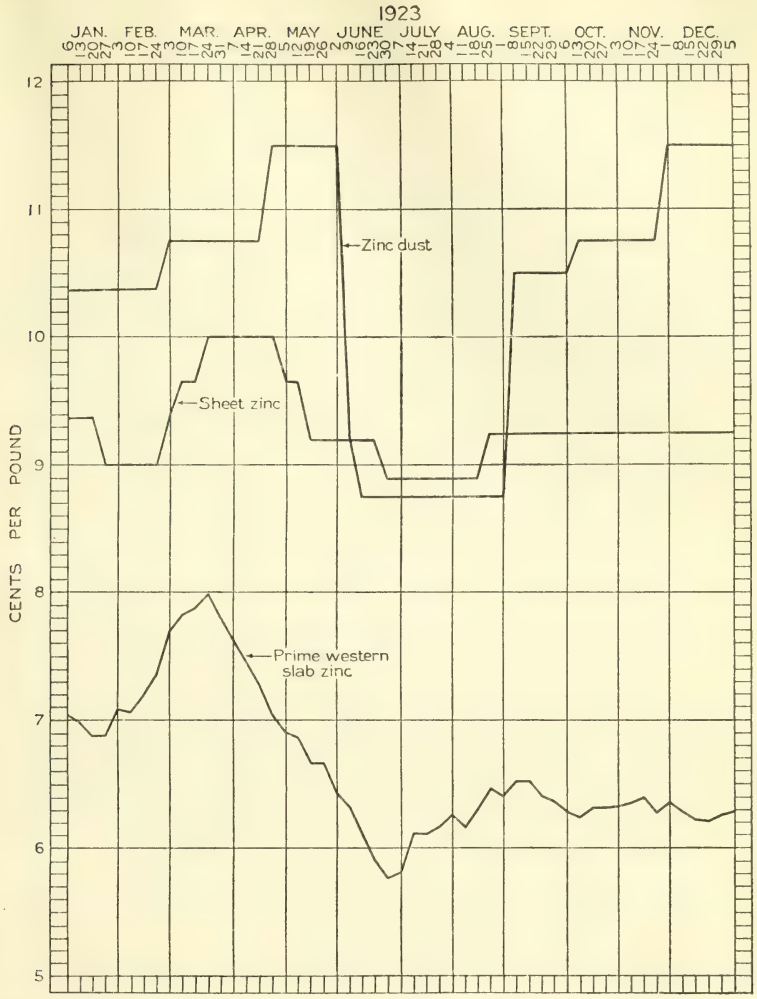

FIGURE 2.—Relation of prices of metallic zinc products to the price of prime western zinc in 1923 at St. Louis.

Distilled and electrolytic zinc produced in the United States, 1918-1923.

Year	Domestic primary		Foreign primary		Redistilled secondary		Total	
	Short tons	Value [a]	Short tons	Value [a]	Short tons	Value [a]	Short tons	Value [a]
1918	492, 405	$89, 618, 000	25, 522	$4, 645, 000	9, 918	$1, 805, 000	527, 845	$96, 068, 000
1919	452, 272	66, 032, 000	13, 471	1, 967, 000	19, 748	2, 883, 000	485, 491	70, 882, 000
1920	450, 045	72, 907, 000	13, 332	2, 160, 000	21, 371	3, 462, 000	484, 748	78, 529, 000
1921	198, 232	19, 823, 000	2, 268	227, 000	17, 573	1, 757, 000	218, 073	21, 807, 000
1922	353, 274	40, 273, 000	1, 003	114, 000	32, 988	3, 761, 000	387, 265	44, 148, 000
1923	508, 335	69, 134, 000	2, 099	285, 000	39, 434	5, 363, 000	549, 868	74, 782, 000

[a] Value based on the average selling price for all grades.

TIN

By Bertrand Leroy Johnson

PRODUCTION AND DEVELOPMENT

Tin mining in the United States in 1923 was carried on only at the tin-bearing gold placers of Alaska, and the small output of Alaskan tin-bearing concentrate (3.05 short tons) was obtained entirely from the Hot Springs district of the Tanana region, where it was recovered incidentally to gold mining. The recoverable content of the metallic tin in the concentrate produced was about 1.9 short tons.[1]

Tin mined in the United States (including Alaska), 1916–1923, in short tons

[Metallic tin obtainable from concentrates produced in tin mining]

1916	140	1920	22
1917	110	1921	4
1918	69	1922	1. 4
1919	56	1923	1. 9

SMELTING INDUSTRY

Two tin-smelting plants in operation in the United States produced 7,466 short tons of metallic tin in 1923, wholly from Bolivian concentrate. The producing smelters were those of the American Smelting & Refining Co., Perth Amboy, N. J., and the Williams Harvey Corporation, Brooklyn, N. Y. Both plants are reported to have ceased the smelting of concentrates shortly after the middle of the year.

Smelter output of metallic tin in the United States, 1916–1923, in short tons

1916	2, 261	1920	17, 652
1917	6, 065	1921	11, 542
1918	10, 284	1922	9, 108
1919	12, 236	1923	7, 466

IMPORTS AND EXPORTS[2]

Tin concentrate imported into the United States, 1916–1923

[General imports]

Year	Short tons	Value	Year	Short tons	Value
1916	8,040	$4,032,460	1920	34,148	$18,795,162
1917	9,054	4,743,099	1921	15,340	5,672,861
1918	18,394	11,444,401	1922	13,804	5,504,434
1919	19,196	11,871,948	1923	3,015	2,169,055

[1] Data regarding the Alaska tin-mining industry were obtained from Alfred H. Brooks, of the U. S. Geological Survey.

[2] Statistics of imports and exports compiled from the records of the Bureau of Foreign and Domestic Commerce by J. A. Dorsey, of the U. S. Geological Survey.

Metallic tin imported for consumption in the United States, 1916–1923

Year	Short tons	Value	Year	Short tons	Value
1916	69,033	$51,802,232	1920	62,795	$73,440,872
1917	72,166	63,870,840	1921	27,101	16,645,719
1918	71,234	93,144,218	1922	67,416	40,797,986
1919	44,849	50,890,019	1923	77,206	61,092,354

The details of the general imports of metallic tin for 1923 are given in the following table:

Metallic tin as bars, pigs, blocks, grains, and granulated, imported into the United States in 1923

[General imports]

Country	Short tons	Value	Country	Short tons	Value
Australia	499	$388,817	India (British)	28	$21,495
Belgium	39	27,968	Japan	114	71,591
Brazil	198	53,805	Java and Madura	4,167	3,246,235
Canada	137	25,702	Netherlands	50	44,737
China	657	443,991	Scotland	7	3,453
England	12,307	10,288,573	Straits Settlements	52,509	41,796,278
France	202	139,489		77,206	61,092,354
Germany	121	106,764			
Hongkong	5,911	4,418,406			

Metallic tin exported from the United States, 1919–1923, in short tons

Year	Domestic [a]	Foreign [b]
1919	306	76
1920	700	333
1921	1,154	406
1922	901	329
1923	840	331

[a] Imported as ore and exported as pigs, bars, etc.
[b] Imported as pigs, bars, etc., and exported as such.

CONSUMPTION

The quantity of new (primary) tin made available for consumption in the United States during any year may be estimated by adding the general imports of metallic tin to the quantity of tin produced in the United States and subtracting from the result the sum of the domestic and foreign exports of metallic tin.

New tin made available for consumption in the United States, 1920–1923, in short tons

1920	79,632	1922	75,294
1921	37,083	1923	83,501

The quantity of this new tin actually consumed in the United States during a given year is not susceptible of accurate determination, as a close estimate of the annual consumption is not possible without a knowledge of the stocks in hand in this country.

PRICES

The average price of Straits tin in New York in 1923 was 42.71 cents a pound, as compared with 32.58 cents in 1922.[3] The course of the market during the year is shown in the following table:

Average monthly prices, in cents per pound, of Straits tin in New York in 1923[3]

January	39. 17	May	43. 16	September	41. 63
February	42. 03	June	41. 00	October	41. 86
March	48. 65	July	38. 48	November	44. 11
April	45. 87	August	39. 39	December	47. 14

The average price for the year in London was £202 5s. 1d. a ton of 2,240 pounds. The lowest price was £176⅛, and the highest price was £239¾.[4]

[3] Metal Statistics, 1924, p. 331.

[4] Idem, p. 337.

BISMUTH

By V. C. Heikes

PRODUCTION

According to the best available information, the total supply of metallic bismuth in the United States in 1923 was about 472,000 pounds derived from domestic and imported materials. Nearly two-thirds of this quantity was sold at $2.25 to $2.94 a pound, the smaller lots bringing the higher price. Bismuth was recovered at local refineries receiving lead bullion from smelters, and bismuth fume and residue from lead and tin refineries, two of which treated considerable tin ore and concentrates containing bismuth from Bolivia. Western lead smelters received considerable ore containing bismuth, which was penalized or paid for, according to the ore producer's contract.

IMPORTS AND EXPORTS [1]

Bismuth imported for consumption in the United States, 1916–1923

Year	Pounds	Value	Year	Pounds	Value
1916	76,723	$195,975	1920	72,771	$161,877
1917	69,250	142,300	1921	94,085	114,891
1918	135,700	277,273	1922 [a]	121,505	239,777
1919	57,607	55,179	1923 [a]	62,640	146,178

[a] Also 9,392 pounds of "compounds, mixtures, and salts of bismuth," valued at $8,681, imported Sept. 22 to Dec. 31, 1922. Not separately classified prior to new tariff. Similar imports in 1923 were 11,731 pounds, valued at $13,717.

Brokers in New York City exported bismuth residue and fume for refinement abroad and distributed a considerable amount of the metal to manufacturers of drugs and different brands of alloys. Exports of bismuth are not separately recorded by the Bureau of Foreign and Domestic Commerce.

SOURCES

Ores containing appreciable amounts of bismuth were produced in 1923 from mines in Arizona, Idaho, Montana, Nevada, and Utah. Several mining companies whose lead and copper ores contained bismuth were paid for a few tenths of 1 per cent to 4 per cent of bismuth in addition to other metals, and on some lots the smelting charges were lowered in place of direct payment for the bismuth.

[1] Figures compiled by J. A. Dorsey, of the United States Geological Survey, from the records of the Bureau of Foreign and Domestic Commerce, Department of Commerce.

PRICES

The prices for bismuth quoted in the American trade journals during 1923 ranged from $2.45 a pound in January to $2.55 a pound during the remainder of the year. Throughout the year bismuth was quoted in London at 10s. a pound.

WORLD'S RESOURCES

A table of world's production compiled from official reports was given in Mineral Resources for 1922. Very little additional information has been received since this table was published. The United States is believed to have been the largest producer of bismuth in 1923, and in addition considerable bismuth was recovered from tin ores and concentrates shipped into this country from Bolivia. The exports of minerals from Bolivia in 1921 and 1922, which may be taken as indicating production also, as no minerals are consumed in that country, with other data previously reported by the American consul at La Paz, are given below.

Bismuth exported from Bolivia, 1919–1922

	Average bismuth content (per cent)	1919		1920		1921		1922	
		Kilograms	Value (bolivianos)	Kilograms	Value (bolivianos)	Kilograms	Value (bolivianos)	Kilograms	Value (bolivianos)
Bismuth bars	80	169,451	2,211,335	194,537	2,541,853			136,798	1,359,242
Concentrates	60	38,289	248,703	27,014	175,385	4,708	18,792	15,968	59,469
Residues	30	72,506	315,401	63,175	274,811				
Ores	20	93,830	306,204	153,005	500,532	23,942	66,832	144,048	400,932

The Compagnie Aramayo de mines en Bolivie, whose headquarters in 1922 were removed to Geneva, Switzerland, practically controls the production of bismuth in Bolivia. Its mines are situated in the Sur Chichas district of the Department of Potosi, at Tasna and Chorolque.[2] Bismuth is produced in small quantities in other parts of Potosi—at the Real Socavon mine, in the Cerro of Potosi; at Colquechaca, in the Provinces of Porco and Charcas; at Esmoraca, in Sur Chichas; and at Simon I. Patiño's Salvadora mine, at Uncia. In the vicinity of La Paz it is produced in small quantities at the Milluni mines, owned by Fabulosa Mines Consolidated.

The occurrence of bismuth is discussed in a recent German publication,[3] an abstract of which is as follows:

At Joachimsthal, in Bohemia, bismuth is much less abundant than pitchblende, which is the principal product obtained. The vein formation there is similar to those at Johanngeorgenstadt and Schneeberg. As at those places, mining is directed primarily toward recovery of the silver ores, which are now nearly exhausted and which were abundant in the veins in mica schists. Together with these ores are found also pyrite, chalcopyrite, and varieties of cobalt and nickel ores, which are accompanied by native bismuth, bismuth-

[2] McDonough, D. C. (American consul, La Paz), Bolivian mining industry, 1921: U. S. Geol. Survey Cons. file, No. 5173, Dec. 16, 1922.

[3] Meileitner, K., Edel-Erden u. Erze, Jahrg. 3, Nos. 11/12, pp. 61–63, March; Nos. 13/14, pp. 74–77, April, 1922.

cobalt ores, and bismuth glance. The bismuth ores, however, occur only in small quantities and have not been mined by themselves.

The occurrence of native bismuth in considerable masses in the silver-cobalt veins at Temiskaming Lake, in Ontario, is noteworthy. Mining there is directed to the recovery of cobalt, nickel, silver, and arsenic, in comparison with which bismuth is of minor importance. The veins occur in conglomerate schists or slates and carry principally the ores of the elements named.

The greatest quantity of bismuth in a small area is in Bolivia, at Tasna and Chorolque, in the southern part of the country. The country rock at Tasna consists of clay slates, traversed by dacite dikes, and contains very many ore veins which in different places carry either bismuth ores, tin ores, or arsenic. The bismuth veins are found particularly on the east side of a 4,760-meter mountain and on a smaller mountain to the east of this. They are as much as 1 meter thick and carry, besides a gangue consisting practically only of quartz and siderite, bismuth glance, cassiterite, arsenopyrite, pyrite, chalcopyrite, magnetite, and hematite, also chalcocite and wolframite. The bismuth is commonly altered into bismuth ocher, with which bismuth carbonate, the oxychloride daubreeite, and rhagite occur. Native bismuth is rare in these veins. Very similar to these are the veins at Cerro de Chorolque, except that there native bismuth also occurs, together with bismutite in small quantities. These Bolivian bismuth deposits constitute a local variation of the silver-tin formations of that region and are in some essentials different from the silver and tin deposits proper, although these contain abundant bismuth, especially the tin ores, in which bismuth is almost nowhere lacking. At Illampu and Inquisivi, also in Bolivia, are veins in clay slates which contain, together with tourmaline, epidote, apatite, calcite, and quartz as gangue materials, the ore minerals glaucodot, arsenopyrite, bismuth, bismutite, bismuth telluride, and others. In origin these deposits are probably related to granite eruptives in the neighborhood.

Bismuth occurs also in association with tin in the Saxon Erzgebirge, especially at Altenberg. The innumerable very thin veins there traversing the granite, which is metamorphosed to a greisen, contain besides cassiterite bismuth, arsenopyrite, chalcopyrite, pyrite, molybdenite, bismutite, hematite, magnetite, and wolframite and the gangue minerals quartz, topaz, zinnwaldite, and fluorite. Although the bismuth content is meager, it is recovered. The veins are for the most part so small that they look like strings or threads, and the entire so-called stockwork with its veins must be mined. Other tin deposits in the Erzgebirge are less rich in bismuth.

In contrast to these occurrences bismuth is found somewhat more abundantly in the tin veins in some places in Cornwall and is there mined with the tin. The accompanying minerals in Cornwall are the same as in Saxony.

Formerly (1864–1867) tin veins were mined in Meymac, in the Department of Corrèze, in France, on account of their bismuth content. The veins traverse granite and contain, together with very little cassiterite, somewhat more bismuth, bismutite, and their weathering products; also pyrite, chalcopyrite, molybdenite, arsenopyrite, scheelite, and other minerals disseminated in quartz but not in minable quantities.

Mexico is fairly rich in bismuth. Only a little occurs with the tin veins, as for example, at San Luis Obispo. More occurs in the silver ore bodies, as at Durango, in Chihuahua, but most of the bismuth occurs in the bismuth ore bodies, which are not abundant but are present in the Sierra de Santa Rosa at Guanajuato. They occur in Tertiary quartz porphyry and carry as principal ore minerals native bismuth and the tellurium-bearing guanajuatite.

Bismuth is more abundant in Australia, where the tin deposits in particular contain it. In Queensland the Herberton district yields besides tin also bismuth and copper. The Lancelot mine, opened in ancient sediments, carries, besides cassiterite, quartz, native bismuth, and chalcopyrite. Still more bismuth is contained in some gold quartz veins—for example, those at Charters Towers, which carry, in addition to native gold, gold-bearing bismutite, some undetermined tellurium-bismuth compounds, native bismuth, and oxidation products such as bismuth ocher and bismuth carbonate. With these are also barite, pyrobiotite, sphalerite, galena, and chalcopyrite. This interesting and significant paragenesis of gold and bismuth minerals is found also in the near-by parts of New South Wales, particularly in the New England district. There the veins are found in a contact zone between granite and metamorphosed slates. They contain, besides quartz and gold, native bismuth, some bismuth glance, and molybdenite, together with bismuth ocher and molybdenum ocher. Bismuth is also

found in the tin deposits of New South Wales and Tasmania, mostly as native metal and in tin placers developed by disintegration of veins.

The remaining occurrences of bismuth minerals are numerous but of no commercial importance. They are practically all vein deposits. There are only a few tin veins in South Africa, for example, from which bismuth is entirely absent, although the principal tin deposits of the Moluccas, Banca, and Billiton, in the Dutch East Indies, appear to be free of bismuth. Bismuth accompanies cobalt and nickel ores that occur as arsenides and sulphides. Johanngeorgenstadt, Schneeberg, and others have already been referred to. In lesser amounts bismuth is also present in other associations, as at Wittichen, in Schwarzwald, where bismuth glance, wittichenite, emplektite, klaprothite, and bismuth-bearing fahlerz have been observed, but all in only meager amounts. At Schwarzenberg, in Saxony, veins in granite contain iron oxide and manganese ores, together with asbolite, bismuth ocher, agricolite, and native bismuth, which are recovered by mining. The copper ore veins of Svartdal, in Telemarken, Norway, likewise contain some bismuth ores and especially bismuth glance, bismuth, and bismuth telluride. Some bismuth has even been found in copper deposits—for example, in many places in Rhineland and Westphalia—but in those places it is only of mineralogic significance. The same is true for the genetically entirely different occurrences of Oravicza, in Banat, and of Rezbanya, in Siebenbürgen, which are contact-metamorphic deposits and in which some bismuth glance is present.

Finally, bismuth and bismuth glance are locally found in the so-called Rücken of the central German copper-bearing shales—for example in the "Bismuthrücken" at Bieler, in Spessart, where they are fairly abundant with siderite, and also in some barite veins of the Spessart region, as at Waldaschaff, where wittichenite and bismuth ocher have been observed.

The distribution of bismuth in nature is, as has been indicated, not very abundant. It has not been observed in more than traces in eruptive rocks, and it is essentially restricted to ore veins, in which it is only exceptionally the quantitively dominant metal. As a rule it accompanies other elements in lesser amounts, showing a preferential association with tin, cobalt, gold, silver, and copper, especially the first two, with which it is a characteristic associate. It occurs only exceptionally in other kinds of ore deposits, as in the Rücken of the Kupferschiefers and in the contact deposits at Resbanya and Banat. Even in these occurrences it is associated with cobalt or copper. Everything considered, bismuth belongs to the rarer elements. According to J. H. L. Vogt, all the bismuth in the uppermost 16 kilometers of the earth's crust constitutes certainly less than 0.0001 per cent of the whole, or about the same amount as silver and cadmium.

SELENIUM

By V. C. Heikes

Only two companies reported the production of selenium in 1923; reports were received from three firms in 1922.

The output of selenium at one copper refinery was smaller in 1923 than in 1922, as a result of the decreased percentage of selenium in the anode muds from the electrolytic treatment of copper bullion.

The sales of selenium in the form of amorphous powder in 1923 amounted to about 64,000 pounds, valued at about $134,400. Most of the selenium sold at $1.75 a pound, but smaller lots brought $2.25 a pound.

Copper refineries situated near Baltimore, Md., and Chrome and Perth Amboy, N. J., have in the past been the principal producers.

Selenium, produced in the United States, sold in 1917–1923

Year	Pounds	Value	Year	Pounds	Value
1917	39,630	$70,000	1921	55,978	$89,148
1918	103,694	206,540	1922	123,565	177,542
1919	60,025	125,966	1923 (estimate)	64,000	134,400
1920	92,141	175,508			

According to the Bureau of Foreign and Domestic Commerce, the imports of selenium and salts of selenium during 1923 amounted to 940 pounds, valued at $1,653.

Most of the supply of selenium was in demand by the glass and ceramic industries, and a little of it was used in experiments. At the University of Wisconsin a cheap method of making selenic acid has been developed, and some well-directed effort has been applied to the manufacture and marketing of selenium oxychloride. According to Lenher,[1] selenium oxychloride possesses certain properties as a solvent of rubber,[2] and its action on other organic substances is remarkable. Skowronski[3] says that selenium can not be used for electroplating, for the elemental red selenium is deposited. Selenium is recovered in the United States from silver bullion and slimes from the cyanidation of silver ores.[4] These products are sold

[1] Lenher, Victor, Occurrence, chemistry, and uses of selenium and tellurium: Am. Inst. Min. Met. Eng. Trans., vol. 69, pp. 1035–1057, 1923.
[2] Frick, C. E., The action of selenium oxychloride on pure rubber: Am. Chem. Soc. Jour., vol. 45, No. 7, July, 1923.
[3] Lenher, Victor, op. cit., p. 1056.
[4] U. S. Geol. Survey Mineral Resources, 1921, pt. 1, p. 140, 1924.

to refiners, and the residues from the refinery reach certain copper smelters, where selenium finds its way into the blister copper and is ultimately recovered by treatment of the refinery anode slime.

Selenium is found in association with sulphur,[5] to which in many respects it is quite similar. Some deposits of native sulphur, notably those in the Lipari Islands, Kilauea, and Japan, show a red-brown coloration which is readily distinguished from that of other sulphur; this red-brown sulphur contains a small amount of selenium. A large part of the selenium that has come to the United States resulted from the roasting of Scandinavian pyrites, one of the large sources of European sulphuric acid. It was in flue dust from the roasting of this pyrite that the element was discovered by Berzelius in 1817. Greek and Spanish pyrites carry a small amount of selenium. The production of Mexican selenium, the source of which is not mentioned, was reported[6] to have increased in 1923 over the output of 1922, and this material may prove a competitor with American selenium. The customary method of preparing selenium for market is described by Addicks,[7] and Lenher[8] believes that the copper refineries are in a position to produce considerably more than the present annual output, which has been close to 100,000 pounds.

[5] Lenher, Victor, op. cit., p. 1035.
[6] Meyer, H. C., Uncommon ores and metals: Eng. and Min. Jour.-Press, vol. 117, No. 3, p. 90, Jan. 19, 1924.
[7] Addicks, Lawrence, Copper refining, p. 113, 1921.
[8] Lenher, Victor, op. cit., p. 1054.

TELLURIUM

By V. C. Heikes

Most of the total supply of metallic tellurium in the United States in 1923, amounting to less than 1,000 pounds made by two producers, the Raritan Copper Works and the U. S. S. Lead Refinery (Inc.), was sold at an average price of $2 a pound. Manufacturers of electrical equipment, electroplating works, and chemical laboratories bought the largest quantities. Smaller lots of a few pounds each were distributed to laboratories for experiments.

The production of tellurium and its compounds is very small, but the copper refineries of the United States could produce annually between 100,000 and 150,000 pounds of the element should uses be found.[1]

Increasing use of tellurium as a dip for staining silverware in the electroplating industry was noted in 1923, and Skowronski[2] states that tellurium is easily electroplated from a sulphate solution. This method may be used as a means of refining or recovering tellurium from solutions.

The addition of diethyl telluride to motor gasoline to increase power and to prevent knocking in the engine was not found feasible unless the motor industry should conform to a special type of engine and take at least 1,500 tons of metallic tellurium a year. This discovery, however, led to other experiments, and lead tetraethyl, a more plentiful compound, was proved valuable.[3]

Metallic tellurium crystals in contact with crystals of artificial zinc oxide are used as detectors in the wireless industry and have a minor use in medicine.

The occurrence of tellurium has been mentioned in previous volumes of Mineral Resources.

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[1] Lenher, Victor, Occurrences, chemistry, and uses of selenium and tellurium: Am. Inst. Min. Met. Eng. Trans., vol. 69, pp. 1035–1057, 1923.
[2] Idem, p. 1056.
[3] Eng. and Min. Jour.-Press, vol. 117, p. 704, Apr. 26, 1924.

CHROMITE

By Edward Sampson and H. M. Meyer

INTRODUCTION

Chromite is among the few industrially essential minerals used in large quantity in the United States of which the supply is normally obtained in distant lands. Therefore, any disturbance of international trade relations greatly affects the industry. In 1922, for the first time in seven years, there was a promise of return to a stable condition, and in 1923 this promise was fulfilled.

Domestic deposits furnish only an insignificant part of the chromite used in this country, for there is no known deposit of massive chromite in the United States comparable in size to the great deposits in several foreign countries. The transportation costs to which domestic chromite is subjected are high, for the deposits distant from existing lines do not warrant the construction of special railroads, and the few deposits that are favorably situated with respect to railroad transportation are far removed from the chief markets. In addition to these difficulties, most of the domestic ore is of low grade. Of our annual consumption of about 100,000 tons, only a few hundred tons comes from domestic sources.

PRODUCTION

In 1923 227 long tons of chromite was shipped from the mines, as compared with 355 tons in 1922. These figures are of the same order of magnitude as pre-war figures, and it seems improbable that there will be a substantial increase in the near future. The 227 tons of chromite shipped in 1923 averaged 47 per cent of chromic oxide (Cr_2O_3), as compared with 49.7 per cent in 1922. These figures compare favorably with the content of the imported grades. The shipments in 1923 were equivalent to 214 tons of 50 per cent ore. Besides this high-grade ore 335 tons of 35 to 45 per cent ore was mined but not shipped. The shipments were the smallest since 1912.

Production was maintained in California by D. J. Sullivan at Gorge Station and P. A. H. Arata near San Luis Obispo; in Maryland by William G. Vance at Jarrettsville; in Montana by M. W. Mouat at Nye City; and in Oregon by F. W. Peet near Prairie City and Harry Sordy on Briggs Creek. M. W. Mouat and Harry Sordy did not ship their product, and William G. Vance shipped only a part of his.

Crude chromite mined and shipped from mines in the United States in 1923, by States

State	Ore containing 45 per cent or more of chromic oxide			Ore containing 35 to 45 per cent of chromic oxide mined (long tons)	Total value of ore shipped
	Mined (long tons)	Shipped (long tons)	Average value		
California	69	69	$20.51		$1,415
Maryland	90	80	23.00		1,840
Montana				22	
Oregon	78	78	7.23	313	564
	237	227	16.82	335	3,819

IMPORTS [1]

Crude chromite imported into the United States, 1920–1923, in long tons

Country	1920	1921	1922	1923		Average value per ton			
				Quantity	Value	1920	1921	1922	1923
Africa:									
British South	39,400	23,318	41,002	52,153	$397,458	$6.81	$3.41	$7.39	$7.62
Portuguese—									
East	11,000		7,100	15,591	135,155	3.97		4.07	8.67
Other			4,000					14.37	
Australia	2,778		4,000			33.95		5.80	
Belgium	239					35.51			
Brazil	3,451					21.36			
Canada	8,491	7,554	801	3,401	66,401	20.00	5.96	10.75	19.52
Cuba	710	600	1	10,420	95,020	28.73	30.00	74.00	9.12
England	3,799		1,900	(a)	5	30.46		10.95	
Germany	1					83.00			
Greece	5,302	8,104	8,600	10,550	107,597	27.25	20.22	12.43	10.20
Guatemala	1,122	401				61.46	52.08		
India (British)	4,500	928	12,677	29,238	276,628	16.67	12.03	9.87	9.46
Oceania (French)	56,682	35,108	7,500	7,410	44,856	10.79	5.64	2.75	6.05
Spain	40					31.25			
Turkey in Asia	12,760	5,822	[b] 2,500			17.71	20.26	18.56	
Turkey in Europe		1					99.00		
	150,275	81,836	90,081	128,763	1,123,120	12.79	8.00	8.23	8.72

[a] Quantity not recorded.
[b] Listed by Bureau of Foreign and Domestic Commerce as Greece in Asia.

It appears that while Rhodesia is sending more chromite to the United States she is having to meet increased competition from India for European markets. Production in Rhodesia increased from 85,000 metric tons in 1922 to 88,000 tons in 1923. Probably the imports recorded as from British South Africa and Portuguese Africa cover the Rhodesian imports into the United States. The imports of chromite into the United States from British India in 1923 (29,238 long tons) were considerably larger than the total production for that country in 1922 (22,777 long tons). The increase in imports was due largely to the greatly increased activity in Mysore. In 1923 more than 14,000 tons of ore from the Mysore field was imported into the United States for use in refractories, whereas in 1922 almost the entire output of India came from Baluchistan. Imports from Greece increased from 8,600 long tons in 1922 to 10,550 tons in 1923. It is reported that the Volo mine is being operated by

[1] Import figures have been compiled by J. A. Dorsey, of the U. S. Geological Survey, from records of the Bureau of Foreign and Domestic Commerce.

agreement with the Harbison-Walker Refractories Co. and that the ore from this mine is being used for refractories, for which it is well suited. The imports of ore from Cuba in 1923 were 10,420 long tons, compared with only 1 ton in 1922. This large increase is due to the importation of chromite by the Bethlehem Steel Co., which operated the Caledonia mine, in the Mayari district. The ore from this mine carried about 46 per cent of chromic oxide.

The imports of chromium compounds are small as compared with the consumption.

Chromium compounds imported for consumption in the United States, 1919–1923

Year	Chromic acid			Chromate and bichromate of potash			Chromate and bichromate of soda		
	Pounds	Value		Pounds	Value		Pounds	Value	
		Total	Average		Total	Average		Total	Average
1919				15,450	$4,271	$0.28			
1920	1,100	$90	$0.08	4,414	2,690	.61			
1921	1,969	674	.34	73,011	6,772	.09	64,236	$5,308	$0.08
1922	4,663	1,289	.28	8,584	1,676	.20	22,731	1,540	.07
1923	4,632	2,026	.44	5,563	1,033	.19	245	73	.30

Year	Chrome or chromium and ferrochromium [a]			Chromium chloride and sulphate		
	Long tons	Value		Pounds	Value	
		Total	Average		Total	Average
1919	414	$100,404	$243			
1920	1,751	428,619	245	[b]	[b]	[b]
1921	452	106,669	236			
1922	397	118,870	299			
1923	1,481	281,279	190	2,771	$654	$0.24

[a] Beginning Sept. 22, 1922, classification covers chromium metal, chromium-vanadium, and ferrochromium.

[b] Not separately classified prior to new tariff. None recorded Sept. 22 to Dec. 31, 1922.

CONSUMPTION

Domestic sales, imports, and supply of chromite in the United States, 1919–1923

Year	Domestic sales			Imports			Apparent available supply		
	Long tons	Value		Long tons	Value		Long tons	Value	
		Total	Average		Total	Average		Total	Average
1919	5,079	$129,302	$25.46	61,404	$1,381,497	$22.50	66,483	$1,510,799	$22.72
1920	2,502	44,857	17.93	150,275	1,921,824	12.79	152,777	1,966,681	12.87
1921	282	2,900	10.28	81,836	654,602	8.00	82,118	657,502	8.01
1922	355	7,288	20.53	90,081	741,186	8.23	90,436	748,474	8.28
1923	227	3,819	16.82	128,763	1,123,120	8.72	128,990	1,126,939	8.74

Imports of chromite plus domestic shipments were 128,990 long tons in 1923, compared with 90,436 long tons in 1922. Imports of chrome or chromium, ferrochromium, and chromium-vanadium increased from 397 long tons in 1922 to 1,481 tons in 1923. As the output of ferrochromium in the United States comes mainly from one producer the Geological Survey is not permitted to show statistics regarding ferrochromium production or shipments.

A list of the makers or shippers of ferrochromium in 1923 is given below.

Electro Metallurgical Co., New York City.
Ferro Alloy Co., Denver, Colo.
Metal Alloys (Inc.), Watervliet, N. Y.
Metal & Thermit Corporation, New York City.
Southern Manganese Corporation, Anniston, Ala.
U. S. Ferro Alloy Corporation, New York City.

WORLD'S PRODUCTION [2]

Crude chromite produced by different countries, 1919–1923, in metric tons

Country	1919	1920	1921	1922	1923
Australia [a]	254	1,643	63	537	1,211
Brazil [b]	4,877	3,506			
Canada [c]	7,748	9,993	2,538	696	2,654
Cuba [b]	14,693	721	610		10,587
Great Britain [d]	152	1,118		605	(e)
Greece [f]	4,070	12,492	5,919	9,927	13,350
Guatemala [b]	1,686	1,140	401		
India [g]	37,024	27,231	35,320	23,143	(e)
Japan [h]	6,012	3,969	3,368	3,757	(e)
New Caledonia [i]	23,548	91,534	29,458	19,374	23,226
Norway [j]	460				(e)
Rhodesia [k]	32,007	54,674	45,529	84,799	87,762
Russia [l]	(e)	2,965	4,013	308	(e)
Turkey (Asia Minor) [m]	(e)	25,000	(e)	2,540	
Union of South Africa [n]			1,078	87	
United States	5,161	2,542	287	361	231
Yugoslavia [o]		10	10	15	(e)
	137,692	238,538	128,594	146,149	(e)

[a] 1919–1922: New South Wales, Dept. Mines Ann. Repts.; Queensland, Undersecretary for Mines Ann. Repts. 1923: Data by Sec. Mines, New South Wales.
[b] Imports into United States, Bur. Foreign and Domestic Commerce.
[c] 1919–1920: Canada Dept. Mines, Mines Branch, Ann. Repts. 1921–1923: Dominion Bur. Statistics.
[d] 1919–1920: Mines and Quarries, General Repts., pt. 3. 1921–1922: Sec. Mines and H. M. Chief Inspector for Mines Dept. Ann. Rept.
[e] Figures not yet available.
[f] 1919–1921: Tableaux statistiques du mouvement minier de la Grèce. 1922–1923: Information furnished by Direction du Service des mines, Athens, Greece.
[g] India Geol. Survey Records.
[h] 1919: Japan Dept. Commerce Bur. Mines. 1920–1921: Information from United States consulate, Yokohama, Japan. 1922: Oil, Paint, and Drug Reporter, July 9, 1923.
[i] 1919–1922: Bulletin de l'Agence des colonies. (Figures represent exports.) 1923: L'Écho des mines.
[j] Norges Bergverksdrift.
[k] Rhodesia, Sec. Mines Repts.
[l] 1920: Mining Jour., London. 1921: U. S. Dept. Commerce, Commerce Repts., June 26, 1922. 1922: Gornyi Zhurnal, Nos. 3 and 4, 1923.
[m] 1920: Estimate based largely on information furnished by E. J. Lavino & Co., importers. 1922–1923: Estimate.
[n] Dept. Mines and Industries Ann. Repts.
[o] 1919: Wray, D. A., Report of geologist attached to the British Economic Mission to Serbia, 1921. 1920–1922: Royal Ministry of Forests and Mines. 1920, exports; 1921–1922, production.

[2] Prepared from data compiled by W. I. Whiteside, of the U. S. Geological Survey.

PRICES

Prices for imported chromite in 1923 as quoted by the Engineering and Mining Journal-Press ranged from $18.50 to $21 a ton for ore from India, c. i. f. Atlantic ports, and from $20 to $28 a ton for ore from Rhodesia and New Caledonia, with New Caledonian ore generally about $2 a ton higher than Rhodesian, until November 17, 1923, when $19.25 a ton was quoted for chromite. On December 15 the quotations ranged from $19.50 to $24, and on December 29 from $19.25 to $22, "depending upon grade and source." The highest quotation on Indian chromite, $21 a ton, was given in August, and the highest on Rhodesian and New Caledonian ore, $28 a ton, was given in January.

LEAD AND ZINC PIGMENTS AND SALTS

By C. E. Siebenthal and A. Stoll

GENERAL CONDITIONS

Lead and zinc pigments and salts are made both by smelting and by chemical processes. Sublimed lead, or basic lead sulphate, and the various lead oxides are examples of lead pigments produced by sublimation in oxidizing furnaces; basic carbonate white lead and the lead salts are made by chemical processes. Sublimed lead, or basic lead sulphate, is made directly from ore, but the lead oxides as well as white lead and lead salts are made from pig lead.

Zinc oxide and leaded zinc oxide are made by the American process directly from ore by sublimation in an oxidizing furnace, but some zinc oxide is made in this country by the French process, in which metallic zinc is sublimated in an oxidizing furnace. Lithopone and zinc salts are made by chemical processes, the zinc base being derived from zinc ore, metallic zinc, galvanizers' ashes, or scrap zinc. Lithopone is made by mixing equivalent portions of solutions of zinc sulphate and barium sulphide, which brings about a mutual precipitation of zinc sulphide and barium sulphate either in chemical combination or as a very intimate mixture.

The quantity of lead and zinc pigments and salts, including lithopone, sold by producers in the United States in 1923, showed on the whole a slight increase over the sales in 1922. There was a 16 per cent decrease in the sales of white and sublimed lead but a 28 per cent increase in the sales of the lead oxides. Zinc oxides and zinc salts showed a slight gain. Sales of lithopone indicated an active year and were the largest in the history of that industry. Changes in the ownership of several lithopone plants occurred during the year, and one new plant was constructed. The plant of the Metals & Chemicals Extraction Corporation, Oakland, Calif., was closed in October and offered for sale. The works at Federal, Ill., formerly operated by the Consolidated Chemical Products Co., have been purchased by the Basic Chemical Manufacturing Corporation. The plant of the Collinsville Zinc Corporation, Collinsville, Ill., idle since 1921, was sold to the St. Louis Lithopone Co. in 1923 and was started up again near the end of the year. The lithopone plant of the Mineral Refining & Chemical Corporation, of St. Louis, was sold and dismantled. A new plant for the production of lithopone was constructed at Depue, Ill., by the New Jersey Zinc Co. The zinc oxide (French process) plants of the International Lead Refining Co. at East Chicago, Ind., and Akron, Ohio, started operations near the first of the year, using electrolytic zinc made by the Anaconda Copper Mining Co. An addition to the plant of W. P. Fuller & Co., San Francisco, doubled its capacity.

PRODUCTION

In this chapter the pigments and salts sold are taken to represent the production, no account being taken of the stocks on hand at the beginning and end of the year.

Lead pigments and salts sold by domestic manufacturers in the United States in 1922 and 1923

	1922			1923		
	Short tons	Value (at plant, exclusive of container)		Short tons	Value (at plant, exclusive of container)	
		Total	Average		Total	Average
Sublimed lead, or basic lead sulphate:						
White	13,765	$1,829,865	$132.94	11,949	$1,959,068	$163.95
Blue	972	129,230	132.95	800	134,356	167.95
Red lead	30,509	5,104,290	167.30	38,037	7,611,508	200.11
Orange mineral	370	83,022	224.38	646	181,066	280.29
Litharge	58,261	8,892,172	152.63	75,107	14,059,979	187.20
White lead:						
Dry	41,598	5,785,165	139.07	37,786	6,615,114	175.07
In oil	153,393	29,728,230	193.80	125,087	27,010,116	215.93
Lead acetate	(a)	(a)	(a)	(a)	(a)	(a)
Lead arsenate	(a)	(a)	(a)	(a)	(a)	(a)

[a] Statistics for lead arsenate and lead acetate collected biennially by the Bureau of the Census, for odd years. Figures for 1923 not available.

Zinc pigments and salts sold by domestic manufacturers in the United States in 1922 and 1923

	1922			1923		
	Short tons	Value (at plant, exclusive of container)		Short tons	Value (at plant, exclusive of container)	
		Total	Average		Total	Average
Zinc oxide [a]	128,465	$17,994,704	$140.07	126,987	$18,750,972	$147.66
Leaded zinc oxide [a]	19,613	2,251,601	114.80	23,504	2,815,985	119.81
Lithopone	83,360	9,214,040	110.53	98,199	11,608,443	118.21
Zinc chloride, 50° Baumé	41,627	2,009,147	48.27	42,431	1,958,187	46.15
Zinc sulphate	5,078	251,528	49.53	5,375	261,449	48.64

[a] Zinc oxide containing 5 per cent or more of lead is classed by the Geological Survey as leaded zinc oxide.

Lead pigments sold in the United States, 1919–1923, in short tons

Year	White lead		Sublimed lead or basic lead sulphate		Red lead	Orange mineral	Litharge
	Dry	In oil	White	Blue			
1919	30,085	109,005	9,068	1,350	[a] 32,362	(a)	46,739
1920	33,678	112,017	12,412	928	[a] 34,431	(a)	62,329
1921	26,738	143,545	11,568	463	21,805	381	41,909
1922	41,598	153,393	13,765	972	30,509	370	58,261
1923	37,786	125,087	11,949	800	38,037	646	75,107

[a] Figures for red lead include orange mineral prior to 1921.

Zinc pigments and salts sold in the United States, 1919–1923, in short tons

Year	Zinc oxide	Leaded zinc oxide	Lithopone	Zinc chloride (50° Baumé)	Zinc sulphate
1919	117,639	27,591	78,365	[a] 59,228	[a] 2,763
1920	99,444	30,460	89,373	[a] 68,945	[a] 3,072
1921	74,329	16,103	55,016	59,457	3,295
1922	128,465	19,613	83,360	41,627	5,078
1923	126,987	23,504	98,199	42,431	5,375

[a] Figures represent production.

SOURCE

Metal content of lead and zinc pigments and salts sold in 1922 and 1923, by sources, in short tons

Source	1922				1923			
	Lead		Zinc		Lead		Zinc	
	Pigments [a]	Salts [b]	Pigments	Salts	Pigments [a]	Salts [c]	Pigments	Salts
Domestic ore	13,892	([b])	91,874	1,801	13,612	([c])	115,490	1,573
Foreign ore		([b])	1,238			([c])	480	
Metal	241,096	([b])	16,298	1,041	236,541	([c])	25,780	6
Secondary material [d]	111	([b])	8,609	9,016		([c])	10,322	10,719
	255,099	([b])	118,019	11,858	250,153	([c])	152,072	12,298

[a] Includes also lead recovered in zinc oxide and leaded zinc oxide.
[b] Statistics not collected for 1922.
[c] The source of the lead contained in lead salts is unknown to the Geological Survey. Lead acetate is made from litharge, from granulated lead, and from white-lead residues. Lead arsenate is made from lead acetate or lead nitrate. All having been derived from pig lead, their content has already been taken into statistical account.
[d] Zinc ashes, skimmings, drosses, and old metal.

IMPORTS AND EXPORTS

The following statistics of imports and exports of lead and zinc pigments and salts have been compiled from the publications or records of the Bureau of Foreign and Domestic Commerce, Department of Commerce, by J. A. Dorsey, of the United States Geological Survey.

Basic carbonate white lead, red lead, litharge, and orange mineral imported for consumption in the United States, 1919–1923

Year	Basic carbonate white lead		Red lead		Litharge		Orange mineral	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
1919	21,213	$2,490	7,199	$1,136			39,781	$5,082
1920	159,977	19,449	23,076	1,789	21,002	$2,647	52,094	5,352
1921	124,176	12,598	12,236	689	100	7	77,937	7,830
1922	222,465	21,335	1,405	94	1,770	162	111,419	9,729
1923	336,892	31,386	3,600	220	22,525	1,314	116,293	9,031

Zinc oxide, lithopone, zinc sulphide (white), zinc chloride, and zinc sulphate imported for consumption in the United States, 1919–1923

Year	Zinc oxide				Lithopone	
	Dry		In oil			
	Short tons	Value	Short tons	Value	Short tons	Value
1919	105	$44,338	3	$1,351	739	$122,708
1920	1,431	289,890	14	3,596	1,714	263,240
1921	1,286	145,071	57	17,549	5,247	432,019
1922	2,712	361,599	42	8,595	10,263	885,671
1923	1,036	169,415	89	21,934	10,440	776,383

Year	Zinc sulphide [a]		Zinc chloride		Zinc sulphate	
	Pounds [a]	Value	Short tons	Value	Short tons	Value
1919	10,035	$4,413	1	$192	(b)	$152
1920	45,482	15,027	565	76,495	50	3,038
1921	93,537	8,330	2,199	213,995	17	820
1922	27,159	8,453	1,374	87,509	17	1,064
1923	11,844	5,403	551	44,164	20	3,466

[a] Zinc sulphide is stated in pounds rather than tons because of its high value and smaller quantities.
[b] Less than 1 ton.

White lead and red lead exported from the United States, 1919–1923

Year	White lead [a]		Red lead [b]	
	Short tons	Value	Short tons	Value
1919	14,017	$3,037,292	3,114	$735,177
1920	14,901	3,195,101	1,532	365,575
1921	5,161	993,130	548	115,500
1922	4,598	710,765	1,683	294,133
1923	[a] 5,172	836,261	[b] 1,840	372,828

[a] Sublimed lead has been classified by the Bureau of Foreign and Domestic Commerce with white lead in exports since 1922; the figures for 1923 may possibly include some sublimed lead.
[b] Exports of red lead and litharge have been combined since 1922; the figures for 1923 may include an unknown quantity of litharge.

White lead exported from the United States in 1922 and 1923

[Figures in parentheses not duplicated in totals]

Destination	1922		1923 [a]	
	Short tons	Value	Short tons	Value
Africa	1	$220	(b)	$62
Asia	60	10,897	53	8,602
Australia and Oceania	165	33,644	277	60,391
Australia	(9)	(1,566)	(11)	(2,436)
New Zealand	(1)	(375)	(b)	(45)
Philippine Islands	(141)	(28,348)	(254)	(54,860)
Canada	53	8,386	216	36,145
Cuba	65	14,194	126	25,472
Europe	2,809	391,940	2,680	362,511
Belgium	(938)	(127,275)	(1,272)	(165,115)
France	(56)	(7,821)		
Great Britain	(1,377)	(193,679)	(909)	(128,626)
Netherlands	(417)	(59,749)	(490)	(67,558)
Mexico	124	28,944	99	24,240
Panama	6	1,467	288	60,380
South America	1,199	196,110	1,309	229,054
Brazil	(6)	(1,066)	(12)	(1,961)
Colombia	(22)	(4,251)	(9)	(2,538)
Uruguay	(83)	(12,923)	(144)	(24,729)
Venezuela	(9)	(2,014)	(9)	(2,121)
Other countries	116	24,963	124	29,404
	4,598	710,765	5,172	836,261

[a] White lead and sublimed lead not classified separately after 1922; the figures for 1923 may include an unknown quantity of sublimed lead.
[b] Less than 1 ton.

Zinc oxide and lithopone exported from the United States, 1919–1923

Year	Zinc oxide		Lithopone [a]	
	Short tons	Value	Short tons	Value
1919	14,703	$3,059,276	(a)	
1920	11,164	2,151,544	(a)	
1921	2,511	426,253	(a)	
1922	3,977	593,128	1,616	$169,982
1923	5,024	743,577	1,485	176,624

[a] Not separately enumerated prior to 1922.

Zinc oxide exported from the United States in 1922 and 1923

[Figures in parentheses not duplicated in totals]

Destination	1922		1923	
	Short tons	Value	Short tons	Value
Asia	4	$1,113	68	$10,946
Australia and Oceania	64	11,642	115	19,256
Philippine Islands	(37)	(7,481)	(49)	(8,036)
Canada	3,218	459,819	3,260	477,711
Cuba	33	7,583	42	9,934
Europe	381	53,634	1,188	153,451
France	(70)	(10,214)	(91)	(14,360)
Great Britain	(300)	(41,770)	(1,074)	(134,216)
Italy	(11)	(1,650)	(23)	(4,809)
Mexico	109	23,193	104	18,428
Panama	2	539	25	5,109
South America	123	26,561	149	31,554
Brazil	(14)	(2,869)	(14)	(2,986)
Other countries	43	9,044	73	17,188
	3,977	593,128	5,024	743,577

WORLD'S PRODUCTION OF ZINC OXIDE

The following table showing the production of zinc oxide so far as official figures are available has been compiled by W. I. Whiteside, of the United States Geological Survey.

Zinc oxide produced in countries where reported, 1913–1923, in metric tons [a]

Year	Australia (New South Wales)	Germany	Italy	Poland [b] (Upper Silesia)	United States [c]
1913		25,173	624	(d)	77,220
1914		22,988	842	(d)	85,389
1915		15,494	1,660	(d)	116,136
1916		14,251	1,537	(d)	111,893
1917		18,678	1,592	(d)	118,873
1918		21,097	1,356	(d)	115,212
1919	172	16,441	862	(d)	131,750
1920	e 703	22,957	1,302	(d)	117,846
1921	e 300	f 362	249	(d)	82,038
1922		(g)	715	290	134,333
1923		(g)	1,033	373	136,522

[a] In addition to the countries listed, Canada reports a small amount produced, but no figures of production are available. The HA/S Titan Co. of Norway has a capacity of 6,000 tons of zinc oxide, but production data are not available.

[b] The only figures available for production in Poland exclusive of Upper Silesia relate to 1921, when 12,149 metric tons was reported.

[c] Includes leaded zinc oxide.

[d] Included under Germany.

[e] Includes zinc-lead oxide.

[f] Upper Silesia only.

[g] No data available.

CUSTOMS DUTIES

Mineral Resources for 1922 contained a table comparing the tariff rates imposed on lead and zinc pigments and chemicals in the tariff acts of 1909, 1913, and 1922. The tariff act of 1922 contains the following paragraphs relating to lead and zinc pigments and salts:

Par. 47. Lead: Acetate, white, 2½ cents per pound; acetate, brown, gray, or yellow, 2 cents per pound; nitrate, arsenate, and resinate, 3 cents per pound; and all other lead compounds not specially provided for, 30 per centum ad valorem.

Par. 74. Lead pigments: Litharge, 2½ cents per pound; orange mineral, 3 cents per pound; red lead, 2¾ cents per pound; white lead, 2½ cents per pound; all pigments containing lead, dry or in pulp, or ground in or mixed with oil or water, not specially provided for, 30 per centum ad valorem.

Par. 79. Zinc oxide and leaded zinc oxides containing not more than 25 per centum of lead, in any form of dry powder, 1¾ cents per pound; ground in or mixed with oil or water, 2¼ cents per pound; lithopone, and other combinations of mixtures of zinc sulphide and barium sulphate, 1¾ cents per pound.

Par. 93. Zinc chloride, $1\frac{3}{10}$ cents per pound; zinc sulphate, three-fourths of 1 cent per pound; and zinc sulphide, 1½ cents per pound.

SPECIFICATIONS FOR LEAD AND ZINC PIGMENTS

The departmental committee on standardization of paint specifications, later the Federal Specifications Board, has recommended specifications for the purchase of materials by the Government. Those relating to lead and zinc pigments have been published in circulars by the Bureau of Standards, as follows:

84. Basic carbonate white lead, dry and paste. Issued December 27, 1919.
85. Basic sulphate white lead, dry and paste. Issued January 26, 1920.
87. Zinc oxide, dry and paste. Issued February 16, 1920.
88. Leaded zinc oxide, dry and paste. Issued February 16, 1920.
90. Red lead, dry and paste. Issued April 3, 1920.
111. Flat interior lithopone paint, white and light tints. Issued June 24, 1922.
147. Gloss interior lithopone paint, white and light tints. Issued September 19, 1923.

PRICES AND VALUE

The total amount and the average per ton received for sales of each lead and zinc pigment and salt are given in the tables on page 120. Figure 3 shows the relation of the average weekly price of lead in New York to the weekly quotations on several pigments and salts of lead as given in the Oil, Paint, and Drug Reporter, and Figure 4 shows the relation of the weekly average quoted price of prime western slab zinc in St. Louis to the weekly quotations on certain pigments and salts of zinc as given in the same journal. The qualities and conditions of the pigments and salts on which the prices were quoted are designated as follows:

Sublimed lead, or basic lead sulphate (white), "in casks."
White lead, "American, dry, in casks."
Litharge, "commercial, powdered, in casks."
Red lead, "dry, in casks."
Orange mineral, "American."
Lead acetate, "brown, broken."
Lead arsenate, "paste."
Zinc oxide, "commercially lead-free."
Lithopone, "in barrels."
Zinc chloride, "fused."
Zinc sulphate, "industrial."

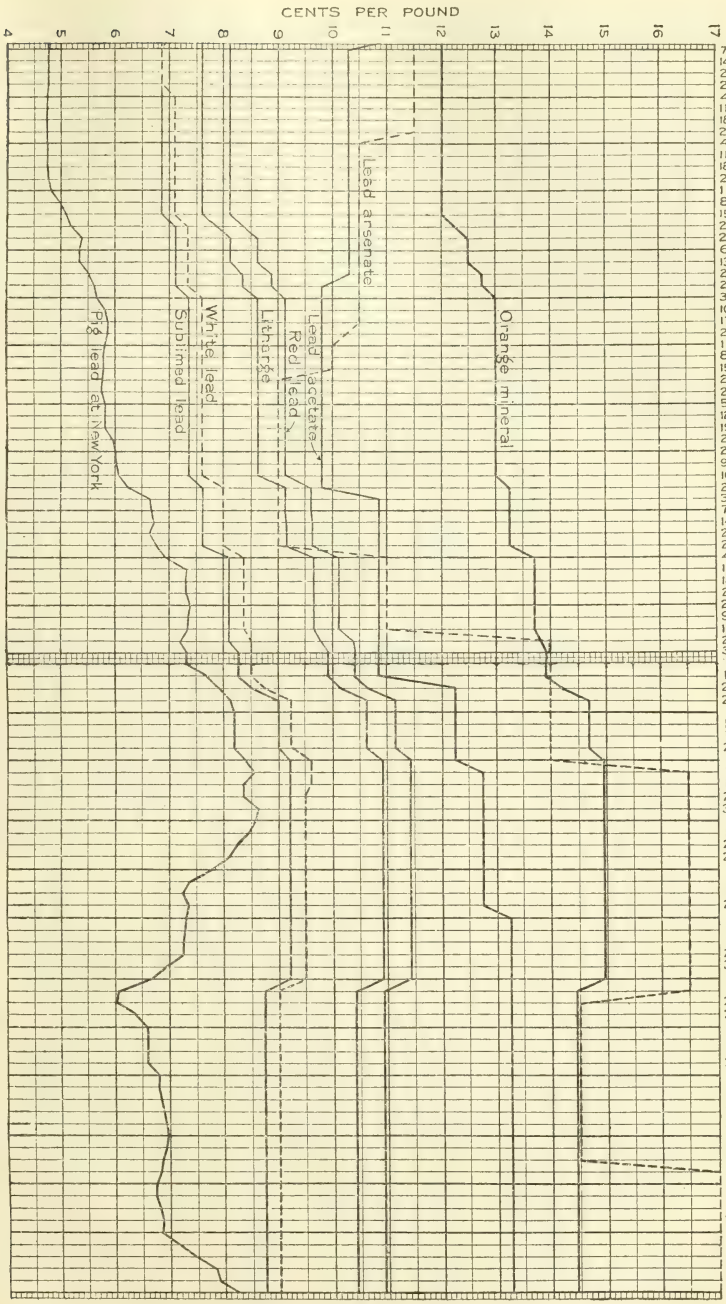

FIGURE 3.—Relation of weekly prices o flead pigments and salts to the average weekly quoted price of lead at New York, 1922-23

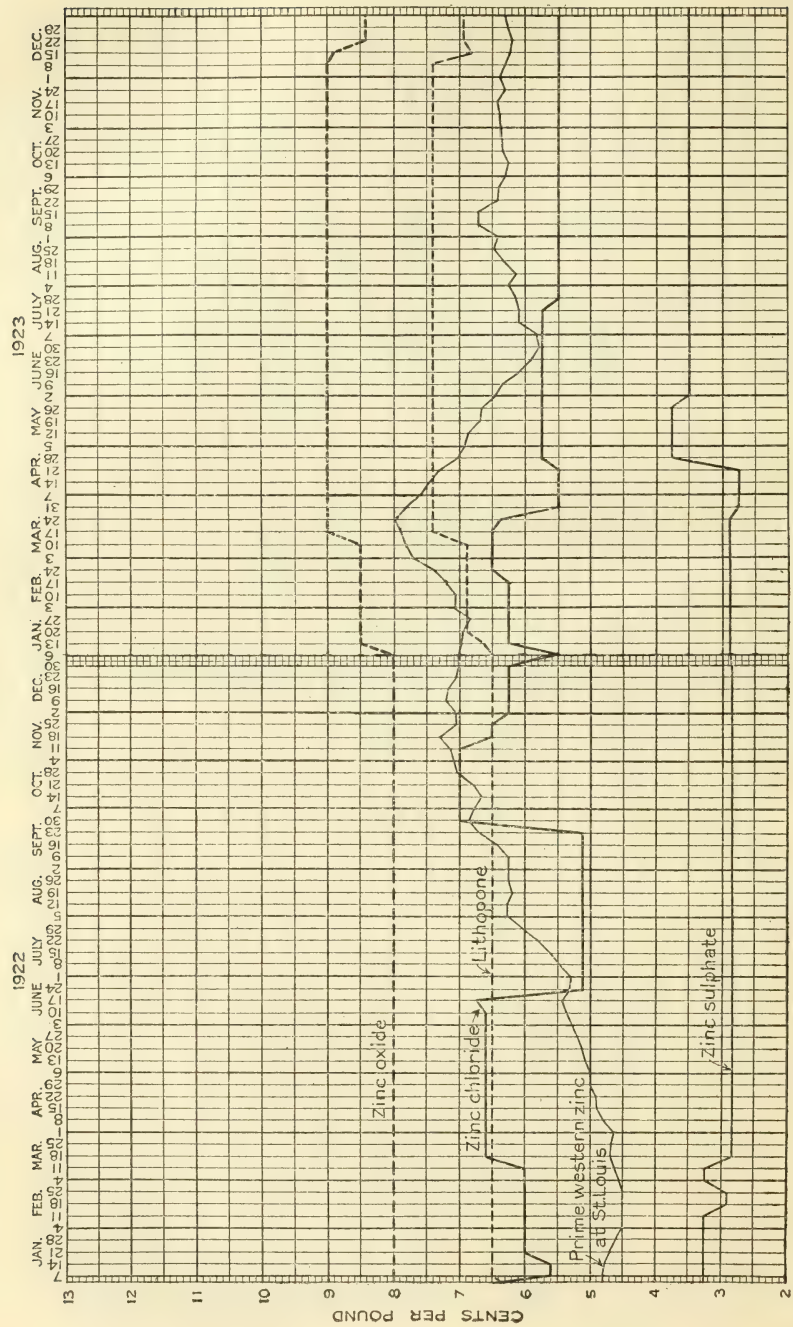

FIGURE 4.—Relation of weekly prices of zinc pigments and salts to the average weekly quoted price of prime western zinc at St. Louis, 1922-23

PRODUCERS

Producers of lead and zinc pigments and salts are listed below, but the list includes some plants that did not operate in 1923.

White lead:	
Anaconda Lead Products Co. (electrolytic process)	East Chicago, Ind.
Carter White Lead Co	South Chicago, Ill.
E. I. du Pont de Nemours & Co	Philadelphia, Pa.
Eagle-Picher Lead Co	East St. Louis, Ill.
Do	Cincinnati, Ohio.
Euston Lead Co	Scranton, Pa.
W. P. Fuller & Co	South San Francisco, Calif.
John T. Lewis & Bros. Co	Philadelphia, Pa.
Matheson Lead Co	Long Island City, N. Y.
National Lead Co	Melrose, Calif.
Do	Chicago, Ill.
Do	St. Louis, Mo.
Do	Brooklyn, N. Y.
Do	Port Richmond, N. Y.
Do	Cincinnati, Ohio.
National Lead & Oil Co. of Pennsylvania	New Kensington, Pa.
Sherwin-Williams Co	Chicago, Ill.
United Lead Co	Perth Amboy, N. J.
Wetherill & Bro	Philadelphia, Pa.
Sublimed lead, or basic lead sulphate:	
Eagle-Picher Lead Co	Joplin, Mo.
St. Louis Smelting & Refining Works of National Lead Co	Collinsville, Ill.
Red lead, orange mineral, and litharge:	
Chadwick-Boston Lead Co.[1]	Cambridge, Mass.
Eagle-Picher Lead Co	East St. Louis, Ill.
Do	Joplin, Mo.
Do	Newark, N. J
Do	Cincinnati, Ohio.
Evans Lead Co	Charleston, W. Va.
W. P. Fuller & Co	South San Francisco, Calif.
John T. Lewis & Bros. Co	Philadelphia, Pa.
Matheson Lead Co	Long Island City, N. Y.
National Lead Co	Melrose, Calif.
Do	Chicago, Ill.
Do	St. Louis, Mo.
Do	Brooklyn, N. Y.
National Lead & Oil Co. of Pennsylvania	New Kensington, Pa.
Pennsylvania Smelting Co	Carnegie, Pa.
Sherwin-Williams Co	Chicago, Ill.
Wetherill & Bro	Philadelphia, Pa.
Zinc oxide and leaded zinc oxide:	
American Smelting & Refining Co.[1]	Omaha, Nebr.
American Steel & Wire Co.[1]	Donora, Pa.
American Zinc & Chemical Co	Langeloth, Pa.
American Zinc Co. of Illinois	Hillsboro, Ill.
American Zinc Oxide Co	Columbus, Ohio.
Bartlesville Zinc Co.[1]	Bartlesville, Okla.
Bertha Mineral Co	Austinville, Va.
Eagle-Picher Lead Co	Hillsboro, Ill.
Empire Zinc Co	Canon City, Colo.
Grasselli Chemical Co	Grasselli, Ind.
Grubnau Chemical Co. (Inc.)[1]	Waldo, N. Mex.
International Lead Refining Co. (French process)	East Chicago, Ind.
Do. (French process)	Akron, Ohio.
Mineral Point Zinc Co.[1]	Depue, Ill.
Do	Mineral Point, Wis.

[1] No manufacturing in 1923.

Zinc oxide and leaded zinc oxide—Continued.	
New Jersey Zinc Co. (of Pennsylvania)	Palmerton, Pa.
Do. (French process)	Freemansburg, Pa.
Ohio Zinc Co.[1]	Canon City, Colo.
Ozark Smelting & Mining Co	Coffeyville, Kans.
River Smelting & Refining Co	Florence, Colo.
Shasta Zinc & Copper Co.[1]	Winthrop, Calif.
Trenton Zinc & Chemical Co	Trenton, N. J.
U. S. Zinc Co	Pueblo, Colo.
Utah Zinc Co.[1]	Murray, Utah.
Western Zinc Oxide Co	Leadville, Colo.
Lithopone:	
Chemical & Pigment Co. (Inc.)[2]	St. Helena, Md.
E. I. du Pont de Nemours & Co	Newark, N. J.
Do	Philadelphia, Pa.
Grasselli Chemical Co	Grasselli, N. J.
Krebs Pigment & Chemical Co	Newport, Del.
Metals & Chemicals Extraction Corporation	Oakland, Calif.
Midland Chemical Co. (Eagle-Picher Lead Co.)	Argo, Ill.
New Jersey Zinc Co. (of Pennsylvania)	Palmerton, Pa.
St. Louis Lithopone Co	Collinsville, Ill.
Sherwin-Williams Co	Chicago, Ill.
United Color & Pigment Co	Newark, N. J.
Zinc salts:	
American Zinc & Chemical Co	Langeloth, Pa.
Arkansas Preservative Co	North Little Rock, Ark.
By-Products Steel Corporation	Weirton, W. Va.
Charles Cooper & Co	Newark, N. J.
Delaware Hard Fibre Co	Wilmington, Del.
General Chemical Co	Chicago, Ill.
Grasselli Chemical Co	Grasselli, Ind.
Do	Grasselli, N. J.
Do	Cleveland, Ohio.
Great Western Electro-Chemical Co	Pittsburg, Calif.
Charles Lennig & Co. (Inc.)	Philadelphia, Pa.
Merrimac Chemical Co	Everett, Mass.
Metals & Chemicals Extraction Corporation[1]	Oakland, Calif.
Monsanto Chemical Works	East St. Louis, Ill.
New Jersey Concentrating Co. (Inc.)	Elizabethport, N. J.
New Jersey Zinc Co. (of Pennsylvania)	Palmerton, Pa.
Pennsylvania Salt Manufacturing Co	Wyandotte, Mich.

[1] No manufacturing in 1923.

[2] Subsidiary of the Glidden Co.

LEAD[1]

By C. E. Siebenthal and A. Stoll

SUMMARY

Statistics of refined lead, 1922 and 1923, in short tons

	1922	1923
PRODUCTION		
Domestic desilverized lead	185,191	291,760
Domestic soft lead	209,250	190,749
Domestic desilverized soft lead	74,305	61,332
	468,746	543,841
Foreign desilverized lead	63,916	74,481
Total refined primary [a] lead	532,662	618,322
Antimonial lead	8,075	14,190
Secondary lead [a]	159,560	194,490
CONSUMPTION [b]		
Apparent consumption of primary lead, refinery stocks disregarded	492,705	573,543

[a] "Primary lead," which is produced directly from ore, is here distinguished from "secondary lead," which is obtained by refining skimmings, drosses, and old metals. The statistics of secondary lead are given on p. 132. In this report the word "lead" used without qualification means primary lead.
[b] For method of calculating consumption see p. 141.

The output of refined lead in the United States from domestic ores in 1923 was 543,841 tons, valued at $76,138,000 at the average selling price of pig lead, a gain, as compared with 1922, of 16 per cent in quantity and of 48 per cent in value.

PRODUCTION

Quantity and value.—The total refined lead produced in the United States from 1720 to 1923 from domestic ores and from foreign ores and base bullion and its value are shown in the following table:

Refined lead produced in the United States, 1720–1923

Year	Short tons							Value	
	Desilverized lead [a] [b]	Desilverized soft lead	Soft lead [b]	Total production [a]	From domestic ores and base bullion	From foreign ores	From foreign base bullion	Average per pound	Total
1720–1912	7,176,497	326,991	2,929,180	10,432,668	8,545,383	1,887,285			$924,600,000
1913	301,160	29,433	131,867	462,460	411,878	13,223	37,359	$0.044	40,696,000
1914	340,397	43,506	158,219	542,122	512,794	7,639	21,689	.039	42,286,000
1915	344,593	44,001	161,461	550,055	507,026	9,581	33,448	.047	51,705,000
1916	335,375	68,244	167,515	571,134	552,228	6,085	12,821	.069	78,817,000
1917	365,998	56,268	188,503	610,769	548,450	15,872	46,447	.086	105,052,000
1918	382,314	47,418	210,463	640,195	539,905	15,334	84,956	.071	90,908,000
1919	266,538	67,938	147,744	482,220	424,433	7,656	50,131	.053	51,115,000
1920	273,135	66,668	189,854	529,657	476,849	8,414	44,394	.080	84,745,000
1921	238,329	52,747	157,513	448,589	398,222	7,110	43,257	.045	40,373,000
1922	249,107	74,305	209,250	532,662	468,746	13,898	50,018	.055	58,593,000
1923	366,241	61,332	190,749	618,322	543,841	24,288	50,193	.070	86,565,000
	10,639,684	938,851	4,842,318	16,420,853	13,929,755	2,491,098			1,655,455,000

[a] The lead content of antimonial lead is excluded; see p. 131.
[b] Desilverized soft lead is excluded.

[1] Chapters on lead giving more than ordinary detail were published in Mineral Resources for 1908 (historical table of production) and 1918 (the lead industry in relation to the World War).

Details for years prior to 1913 are shown in the annual chapters. The value for years prior to 1917 is based upon the average price in New York; beginning with 1917 the value is based on the total sales of each producing company.

The argentiferous lead ores of the Western States are desilverized to recover the silver and to refine the lead. The nonargentiferous or soft lead ores of the Central and Eastern States do not carry enough silver on the average to pay for desilverizing or to make that operation necessary. For certain purposes, however, a considerable quantity of lead ore from southeast Missouri has been desilverized each year.

Production by States.—In addition to the domestic lead ores smelted in this country, small quantities of domestic lead ore have been exported to smelters in Canada. Ores from Washington yielded 1,388 tons of lead at Canadian smelters in 1918 and 3 tons in 1919, but no lead ore from the United States was treated in Canada in 1920–1923.

Primary lead smelted or refined in the United States, 1919–1923, by sources, in short tons

Source of ore	1919	1920	1921	1922	1923
Domestic ore:					
Alaska	645	591	773	324	400
Arizona	5,407	5,987	3,313	7,218	8,828
California	2,004	2,260	614	3,018	5,168
Colorado	18,867	17,752	12,104	11,108	23,885
Idaho	89,091	117,191	99,707	91,487	127,797
Illinois [a]	977	948	271	750	1,286
Kansas [a]	7,951	8,421	10,939	10,900	20,207
Kentucky [a]	83	114	41	73	66
Missouri [a]	150,341	171,999	151,028	202,245	169,323
Montana	17,513	13,231	11,565	14,551	18,345
Nevada	5,958	8,650	3,553	4,264	8,044
New Hampshire	16				
New Mexico	1,418	1,123	384	1,230	1,638
Oklahoma [a]	49,984	68,494	46,902	67,436	59,602
Oregon				[b] 37	47
South Dakota	18	6	2	2	
Tennessee [a]	2,371	2,705		751	1,020
Texas	8	1	1	[b] 5	40
Utah	65,102	64,006	51,872	63,130	104,678
Washington	1,090	2,460	325	478	2,008
Wisconsin [a]	3,975	3,841	1,079	1,323	601
Undistributed	119	201	101	[b] 75	691
Zinc residues	4,887	4,366	713	1,284	362
	427,825	494,347	395,287	481,689	554,036
Foreign ore:					
Africa	644	1,171			99
Australia	69	450			
Canada	1,895	1,186	2,877	3,604	3,632
Central America	12	22	6	14	18
Mexico	2,261	2,729	1,912	7,260	18,857
South America	2,537	2,747	2,235	2,458	1,461
Other foreign	238	109	90	562	211
Foreign base bullion:					
Canada	567	1,919	1,599	2,900	
Mexico	49,564	42,421	41,648	47,118	50,193
South America		54			
	57,787	52,808	50,367	63,916	74,481
Grand total	485,612	547,155	445,654	545,605	628,517

[a] The lead produced by these States is nonargentiferous or soft lead.
[b] Revised figures.

Soft lead.—The lead ores of the Mississippi Valley are almost free from silver, and the lead produced from them is known as "soft lead."

The output of the lead pigment basic lead sulphate or sublimed lead is derived from these ores.

The lead ores from the southeastern Missouri district contain a little more silver (slightly over an ounce to the ton of concentrates in all) than those from other regions of the Mississippi Valley, and likewise small quantities of other metals so that the unrefined lead, though soft, is resistant to acids and is much in favor for sulphuric acid chambers. It is known to the trade as "chemical lead."

Soft lead produced in the United States from domestic ores, 1919–1923, in short tons

Year	Soft pig lead			Soft lead recovered in pigments	Total soft lead	Total domestic lead [a]	Soft lead percentage of domestic lead
	Undesilverized	Desilverized	Total				
1919	147,744	67,938	215,682	[b] 11,179	[b] 226,861	[b] 443,951	51
1920	189,854	66,668	256,522	[b] 15,212	[b] 271,734	[b] 500,093	54
1921	157,513	52,747	210,260	[b] 9,989	[b] 220,249	[b] 414,886	53
1922	209,250	74,305	283,555	13,892	297,447	488,448	61
1923	190,749	61,332	252,081	13,612	265,693	567,247	47

[a] Includes domestic refined lead, domestic lead in antimonial lead, and domestic lead in pigments.
[b] Revised figures.

The zinc ores from Western States that are made into pigments may contain some lead which goes into the pigment, and therefore it is not strictly accurate to speak of the lead content of pigments as entirely soft lead.

In addition to the domestic lead so recovered, some foreign lead is also recovered in pigments. Prior to 1919 this foreign lead was not distinguished from that of domestic origin. In 1919 the quantity of foreign lead recovered in zinc pigments was 351 short tons; in 1920, 808 tons; and in 1921, 169 tons. No foreign lead was used in pigments in 1922 or 1923.

Antimonial lead.—The production of by-product antimonial lead from argentiferous lead ores derived from all sources, as reported by all lead refineries operating in this country, is shown for the period 1871–1914 in Mineral Resources, 1914, and for 1915–1920 in Mineral Resources, 1920.

By-product antimonial lead produced in the United States, 1919–1923

Year	Total lead refined from base bullion (short tons)	Percentage of by-product antimonial lead	Antimonial lead					
			From domestic ore (short tons)	From foreign ore (short tons)	Total			
					Short tons	Value	Antimony content		Lead content, by difference (short tons)
							Short tons	Percentage	
1919	266,538	5.2	9,674	4,200	13,874	$1,513,968	1,943	14.0	11,931
1920	273,135	4.6	9,604	2,931	12,535	1,963,255	2,033	16.2	10,502
1921	238,329	4.2	7,881	2,183	10,064	870,059	1,589	15.8	8,475
1922	249,107	3.2	7,068	1,007	8,075	844,993	1,441	17.8	6,634
1923	366,241	3.9	11,635	2,555	14,190	1,950,370	2,170	15.3	12,020
Average		4.2						15.6	

Lead pigments.—Leaded zinc oxide, zinc-lead oxide, sublimed white lead, and sublimed blue lead are made directly from ore. Each of these pigments is discussed and the output given elsewhere in this volume in the chapter on lead and zinc pigments and salts. The lead content of pigments smelted directly from ore is given in the fourth column of the first table on page 131. The pigments manufactured from pig lead (white lead, red lead, orange mineral, and litharge) are also discussed and the output given in the chapter on lead and zinc pigments.

Secondary lead.—Secondary lead is obtained mainly from skimmings, drosses, old metal, and alloys, such as babbitt, solder, and type metal. The recovery of lead by refining these materials constitutes an integral part of the lead industry.

Secondary lead recovered in the United States, 1919–1923, in short tons

Year	Pig lead	Lead in alloys	Total recovered lead	Value
1919	55,684	66,416	122,100	$12,943,000
1920	56,350	68,300	124,650	19,944,000
1921	46,370	57,410	103,780	9,340,000
1922	75,480	84,080	159,560	17,552,000
1923	96,430	98,060	194,490	27,229,000

Mine production.—The preceding tables give the quantity of lead recovered by smelting and refining operations either as metallic lead, or in the alloy antimonial lead, or as lead in pigments. The origin of the lead is much more accurately shown by the reports of mines, because smelters necessarily treat mixtures of ores, sometimes long after they have been received, so that the actual output of metallic lead may not correspond at all closely to the product of the mines for the same year.

The following table gives the mine output of lead from 1907 to 1923, inclusive. As more fully discussed in the next section, the statistics of mine production, which for years prior to 1921 have heretofore been expressed as lead content of ore mined, have now been reduced to recoverable lead by deducting an assumed loss in smelting and refining, thus making the figures comparable to the statistics of mine production of zinc, which have always been stated as recoverable zinc. In these calculations the loss in smelting and refining has been taken as 2 per cent in smelting at plants with baghouses the soft nonargentiferous lead ores of the Mississippi Valley, and about 5 per cent in smelting and refining the argentiferous lead ores of the Western States. That these assumed factors are close to the truth is shown by the small discrepancy between the mine and smelter output totals as disclosed in the table of comparison on page 136.

Mine production of recoverable lead, 1907–1923, by States, in short tons

State	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923
Alaska			19	28	24		18	28	437	820	852	564	687	875	759	377	410
Arizona	2,214	1,429	1,472	1,281	4,880	3,233	7,668	7,127	10,326	12,854	11,146	5,939	4,847	6,935	3,271	7,535	8,146
Arkansas	12	15	24	62	63	30	18	40	62	267	374	118	27	8	21	42	25
California	1,247	588	713	1,363	664	543	1,669	2,020	2,175	5,893	10,387	6,351	1,695	2,407	562	3,156	4,775
Colorado	[a]44,533	[a]30,823	[a]36,081	[a]38,029	34,840	37,621	43,949	37,106	34,405	35,457	33,995	32,980	18,535	23,315	9,830	11,739	22,849
Georgia														2		4	
Idaho	111,066	98,243	102,593	108,423	129,464	134,988	150,989	165,550	164,350	178,164	186,941	139,981	86,612	118,565	99,235	97,917	121,178
Illinois	813	391	289	366	945	1,256	940	703	935	1,051	1,410	2,228	2,063	1,708	672	1,325	1,381
Iowa	237	50	35	20	59	62	64			14	33						
Kansas	2,504	2,468	1,274	2,364	2,802	2,324	2,378	1,381	1,188	1,615	2,965	7,107	11,057	16,452	18,679	23,271	17,598
Kentucky	33		10	40		104	22	16	246	150	121	181	84	120	69	92	53
Maine													1				
Massachusetts														14			
Missouri	135,902	141,570	156,246	157,796	175,291	173,528	172,594	188,760	206,231	228,426	229,473	190,292	160,024	161,812	180,085	178,412	169,743
Montana	1,780	2,183	1,417	1,950	3,055	3,537	5,195	4,587	6,534	6,458	10,427	17,640	16,358	14,846	10,183	14,884	17,973
Nevada	2,979	3,442	4,674	2,314	1,550	9,263	7,763	6,085	7,903	12,178	13,147	11,075	7,291	10,100	3,594	4,695	9,078
New Hampshire									3	47	48	30					
New Mexico	1,905	437	2,515	2,160	1,483	2,747	1,973	882	2,271	4,107	4,554	4,199	1,443	1,435	339	1,506	1,916
New York												29					
North Carolina						46					1						
Oklahoma	521	1,745	3,358	2,830	2,451	3,320	6,103	7,405	7,160	11,873	25,831	54,975	52,795	64,086	41,552	62,856	66,904
Oregon		1				19	42	7	29	13		4				38	14
Pennsylvania									6					7			
South Dakota		12	59	7	32	11	5	2	2	18	34	27	16	6	2		
Tennessee									1	15	2,404	1,620	2,079	1,880		732	1,250
Texas	12	33	46	33	61	33	113	75	110	25	1	13	7			4	13
Utah	55,071	42,170	70,531	58,579	64,836	66,648	78,910	81,379	94,985	95,708	84,798	79,329	58,819	66,898	44,594	67,666	101,724
Virginia	67	36		94	396	223	775	121	322	692	816	774					
Washington	390	546	137	628	403	61	96	31	141	2,565	4,650	2,504	1,019	2,749	72	691	1,453
Wisconsin	3,429	4,055	3,620	4,325	3,286	2,529	1,829	1,464	2,276	2,982	4,056	4,442	4,130	2,594	972	691	734
	364,715	330,237	385,113	382,692	426,585	442,126	483,113	504,769	542,098	601,392	628,464	562,402	429,589	496,814	414,491	477,633	547,217

[a] Figures revised by C. W. Henderson, of the Denver office, U. S. Geological Survey.

COMPARISON OF NEW YEAR ESTIMATES AND MINE AND SMELTER TOTALS OF LEAD PRODUCTION

The Geological Survey published annually from 1907 to 1920 the statistics of lead output by mines, but owing to lack of knowledge of the average smelting loss for the whole country, the total was, in general, given as lead content of ore mined, not as recoverable lead. Similarly, the New Year estimate of mine production of lead was expressed as lead content, and these figures were compared with each other and with the figures of smelter production of lead. Beginning with 1921, the lead output of the mines has been expressed as recoverable lead by estimating as closely as possible the losses in smelting and refining. If a considerable term of years is taken to eliminate the effects of lag in smelting by reason of which ore accumulates in the smelter bins or the effects of depression in mining on account of which the ore stocks are depleted by being smelted faster than they are renewed by mining, the mine output may be compared with the smelter output and serve as a check on the estimated smelter losses and on the accuracy of the statistics generally. A similar comparison of recoverable and recovered zinc is made in the chapter on zinc in Mineral Resources for 1923, to which the reader is referred for fuller explanation.

MINE PRODUCTION OF LEAD

In view of the generalized character of the New Year estimates of mine production of lead for years preceding 1921, it is not advisable to try to reduce them to the basis of "recoverable" lead. In the following table, therefore, the figures for those years are given in terms of lead content. To make the comparison easier the final figures for those years are also expressed as lead content, but in the other table of mine production in this chapter (p. 133) allowance has been made for smelting losses and the result expressed as recoverable lead.

The New Year estimates of mine production have generally been too low, the error ranging from a small fraction of 1 per cent to nearly 8 per cent. The discrepancy arises largely in the Joplin district, where it is impossible to obtain weekly reports of sales of lead concentrates as accurate as those of zinc concentrates.

Lead content of ore mined in the United States, 1911–1923

Year	New Year estimate (short tons)	Final figures (short tons)	Error in estimate	
			Short tons	Percentage
1911	423,000	441,160	−18,160	4.1
1912	461,000	457,365	+3,635	.8
1913	460,512	500,188	−39,676	7.9
1914	[a]	522,892	[a]	[a]
1915	600,000	561,641	+38,359	6.8
1916	622,000	622,975	−975	.2
1917	640,000	650,949	−10,949	1.7
1918	563,000	581,654	−18,654	3.2
1919	425,000	443,694	−18,694	4.2
1920	511,000	513,533	−2,533	.5
1921	[b] 401,000	[b] 414,491	−13,491	3.3
1922	[b] 464,000	[b] 477,633	−13,633	2.9
1923	[b] 534,000	[b] 547,217	−13,217	2.4

[a] New Year estimate not made.

[b] Recoverable lead.

SMELTER PRODUCTION OF LEAD

The error in the New Year estimates of the production of refined lead by smelters and refineries ranges from a very small quantity to 15,000 tons but has never exceeded 3 per cent. The New Year estimates are based on production for 10 or 11 months plus an estimate by each company of its output for the remainder of the year. Shifting business conditions during the final months will readily account for the small errors in the estimates.

Smelter production of refined lead, of domestic and foreign origin, 1907–1923

Year	New Year estimate (short tons)	Final figures (short tons)	Error in estimate.	
			Short tons	Percentage
1907	(a)	413,389	(a)	(a)
1908	391,000	396,564	−5,564	1.4
1909	444,363	446,909	−2,546	.6
1910	469,682	470,272	−590	.1
1911	487,520	486,979	+541	.1
1912	480,965	480,894	+71	.01
1913	466,843	462,460	+4,383	.9
1914	537,079	542,122	−5,043	.9
1915	565,000	550,055	+14,945	2.7
1916	579,600	571,134	+8,466	1.5
1917	599,000	610,769	−11,769	1.9
1918	638,000	640,195	−2,195	.3
1919	493,000	482,220	+10,780	2.2
1920	538,000	529,657	+8,343	1.6
1921	440,000	448,589	−8,589	1.9
1922	531,000	532,662	−1,662	.3
1923	615,000	618,322	−3,322	.5

[a] No estimate made.

COMPARISON OF MINE AND SMELTER TOTALS

In addition to the domestic lead recovered at smelters as refined desilverized lead from argentiferous ores, as soft lead from Mississippi Valley ores, as lead in antimonial lead, and in pigments, considerable lead is recovered at foreign smelters from lead ores exported from the United States. The Bureau of Foreign and Domestic Commerce does not enumerate separately the exports of lead ore, but except in the later years of the World War they have not been important. In 1917, however, Canadian smelters recovered 4,570 tons of lead from United States ores. The lead salts and many of the lead pigments manufactured in the United States are made from pig lead or some form of manufactured lead, and therefore the lead content does not figure as recovered lead. The following table balances the primary lead recovered in all forms against the estimated recoverable lead in the ore mined, for 17 years, the whole period for which such data are available.

Domestic primary lead balance sheet, 1907–1923, in short tons

Year	Recoverable lead (mine production)	Recovered lead (smelter production)						Mine excess (+) or smelter excess (−)
		Refined desilverized argentiferous lead	Soft lead, nonargentiferous [a]	Lead in antimonial lead	Lead in pigments [b]	Lead recovered from exported ore [c]	Total	
1907	364,715	222,751	129,630	6,551	6,574		365,506	−791
1908	330,237	180,785	130,881	7,614	7,377		326,657	+3,580
1909	385,113	203,149	149,690	7,262	7,292		367,393	+17,720
1910	382,692	206,132	169,270	8,538	7,603		391,543	−8,851
1911	426,585	200,381	191,614	8,094	7,678		407,767	+18,818
1912	442,126	221,480	171,037	[d] 7,325	10,323	63	[d] 410,228	+31,898
1913	483,113	250,578	161,300	[d] 12,463	10,998	135	[d] 435,474	+47,639
1914	504,769	311,069	201,725	[d] 12,957	11,914	31	[d] 537,696	−32,927
1915	542,098	301,564	205,462	[d] 16,410	12,782	137	[d] 536,355	+5,743
1916	601,392	316,469	235,759	[d] 14,699	13,252	2,001	[d] 582,180	+19,212
1917	628,464	303,679	244,771	[d] 13,035	12,870	4,570	[d] 578,925	+49,539
1918	562,402	282,024	257,881	9,220	13,093	1,388	563,606	−1,204
1919	429,589	208,751	215,682	8,339	[d] 11,179	3	[d] 443,954	−14,365
1920	496,814	220,327	256,522	8,032	[d] 15,212		[d] 500,093	−3,279
1921	414,491	187,962	210,260	6,675	[d] 9,989		[d] 414,886	−395
1922	477,633	185,191	283,555	5,810	13,892		488,448	−10,815
1923	547,217	291,760	252,081	9,794	13,612		567,247	−20,030
	8,019,450	4,094,052	3,467,120	162,818	185,640	8,328	7,917,958	+101,492

[a] Includes desilvered soft lead.
[b] Prior to 1919 includes small quantities recovered from foreign ore.
[c] Recovered at Canadian smelters from ores exported from the United States.
[d] Revised figures.

It is not to be expected, of course, that all the recoverable lead mined during any year will be recovered at smelters and pigment plants that same year. There is always more or less lag; in some years more ore will be left in the bins at the end of the year than there was at the beginning of the year, and this will show as a mine excess—that is, more ore was mined than was smelted; in other years the demand for the metal may exceed the rate of ore production, resulting in depletion of ore stocks and giving a smelter excess—that is, more ore was smelted than was mined. But for a long series of years these factors should balance. The table shows annual smelter or mine excesses ranging from less than 400 tons in 1921 to 50,000 tons at the height of the World War.

The recoverable lead in the ore mined during the 17-year period, as shown by the table, amounted to 8,019,450 short tons, and the total lead recovered in all forms, including that recovered in Canada from United States ores, was 7,917,958 tons, constituting a mine excess of 101,492 tons, equal to 1.3 per cent of the total recovered lead.

An apparent mine excess will be shown if the smelting and refining loss is underestimated, for such a low estimate will give an exaggerated figure for the recoverable lead output of the mines. But a real mine excess results when the working stocks of ore are increased on account of increase in size or number of smelters, and similarly when there is an increase in the amount of lead "in process" at the plants, such as has come about by the increased output of the smelters in recent years. Only a very considerable total mine excess at the end of 1917 could have withstood the drain of over 50,000 tons depletion of ore stocks since that year and still have left more than 100,000 tons at the end of 1923.

LEAD SMELTERS AND REFINERIES

The following smelters and refineries were in operation in 1923:

UNITED STATES

California:
Selby—Selby plant, American Smelting & Refining Co. Refinery also.
Colorado:
Durango—Durango plant, American Smelting & Refining Co.
Leadville—Arkansas Valley plant, American Smelting & Refining Co.
Idaho:
Kellogg—Bunker Hill & Sullivan smelter. Refinery also.
Illinois:
Chicago—Goldsmith Bros.' Smelting & Refining Co.[2]
Chicago—Great Western Smelting & Refining Co.[2]
Chicago—Illinois Smelting & Refining Co.[2]
Chicago—U. S. Reduction Co.[2]
Collinsville—St. Louis Smelting & Refining Works of National Lead Co. Refinery also.
Federal—Federal Lead Co.[3]
Indiana:
East Chicago—International Lead Refining Co.[4] Refinery only.
Grasselli—U. S. S. Lead Refinery (Inc.).[5] Refinery only. Betts electrolytic process.
Kansas:
Galena—Galena plant, Eagle-Picher Lead Co.
Missouri:
Granby—American Zinc, Lead & Smelting Co.
Herculaneum—St. Joseph Lead Co.
Joplin—Eagle-Picher Lead Co.
Montana:
East Helena—East Helena plant, American Smelting & Refining Co.
Nebraska:
Omaha—Omaha plant, American Smelting & Refining Co. Refinery only. Betts electrolytic process.
New Jersey:
Irvington—Irvington Smelting & Refining Co.[2]
Newark—Balbach Smelting & Refining Co.
Perth Amboy—Perth Amboy plant, American Smelting & Refining Co.
Oklahoma:
St. Louis—Ontario smelter, Eagle-Picher Lead Co.
Pennsylvania:
Carnegie—Pennsylvania Smelting Co. Refinery also.
Texas:
El Paso—Kansas City Consolidated Smelting & Refining Co.[3]
Utah:
Midvale—United States Smelting, Refining & Mining Co.
Murray—Murray plant, American Smelting & Refining Co.
International—International Smelting Co.[4]

CANADA

British Columbia:
Trail—Consolidated Mining & Smelting Co. of Canada (Ltd.). Refinery also. Betts electrolytic process.
Ontario:
Galetta—Estate of Jas. Robertson.

MEXICO

Aguascalientes:
Aguascalientes—American Smelting & Refining Co.
Chihuahua:
Chihuahua—American Smelting & Refining Co.

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[2] Smelters of secondary materials but treating some lead ores.
[3] Subsidiary of American Smelting & Refining Co.
[4] Subsidiary of Anaconda Copper Mining Co.
[5] Subsidiary of United States Smelting, Refining & Mining Co

Coahuila:
Saltillo—Mazapil Copper Co. (Ltd.).
Torreon—Compañía metalúrgica de Torreón.[6]
Durango:
Asarco (Velardeña)—American Smelting & Refining Co.
Guerrero:
Campo Morado—Reforma Mining & Milling Co.
Nuevo Leon:
Cerralvo—Compañía minera de Peñoles (S. A.).[7]
Monterrey—American Metal Co. (Ltd.). Refinery also.
Monterrey—American Smelting & Refining Co.
San Luis Potosi:
Matehuala—American Smelting & Refining Co. (National Metallurgical Co.)
San Luis Potosi—Compañía metalúrgica mexicana.

TRADE CONDITIONS

WORLD'S SMELTER PRODUCTION

In the following table, prepared by W. I. Whiteside, of the United States Geological Survey, the figures in black-faced type are taken from the official statistics of the countries named; those in ordinary type are taken from the yearbook for 1923 of the American Bureau of Metal Statistics, an association of the copper producers, the lead producers, and the principal zinc producers of this country. The official statistics will be substituted when they are available.

There is always a possibility of duplication in figures showing world's production, for some countries send "work lead" or base bullion to other countries for refining. Furthermore, secondary and antimonial lead are often included in the figures showing the foreign production, so that to put the United States on an equal footing in the statistics it would be necessary to include in its production the domestic output of secondary lead and antimonial lead. The figures for the United States represent refined lead that was smelted in this country, whatever the source of the ore.

World's production of lead, 1913, 1918–1923

[In metric tons, by countries where smelted, but not necessarily refined. Figures in black-faced type are official]

Country	1913	1918	1919	1920	1921	1922	1923
Australia	**110,444**	**163,376**	**83,408**	**5,474**	**51,452**	**105,126**	124,752
Austria	**22,312**	**4,743**	**1,764**	**3,973**	**3,347**	**3,360**	**4,255**
Belgium	**53,590**	**20,630**	**4,225**	**16,040**	**29,750**	**43,580**	51,100
Canada	**17,202**	**17,005**	**16,143**	**13,733**	**28,274**	**40,798**	48,897
Chosen		**264**	**653**	**585**	[a]	[a]	[a]
Czechoslovakia	[b]	[a]	[a]	**2,006**	[a]	[a]	[a]
France	**28,817**	**12,778**	**10,928**	**15,060**	**15,475**	**13,944**	**14,000**
Germany:							
Upper Silesia	**41,360**	**23,960**	**18,580**	**18,008**	**13,743**	[c]**6,188**	[d]
Other Germany	**146,667**	**40,617**	**39,006**	**52,495**	**70,487**	57,500	[a]
Great Britain	18,420	11,083	10,441	11,136	2,474	5,036	6,815
Greece	**18,309**	**4,093**	**3,841**	**5,016**	**5,575**	**4,408**	**4,235**
Hungary	**1,137**	[a]	[a]	[a]	[a]	[a]	[a]
India (Burma)	**5,951**	**19,380**	**19,396**	**24,203**	**34,258**	**39,843**	46,484
Italy	**21,674**	**18,332**	**16,530**	**15,947**	**12,494**	**10,710**	**17,132**
Japan	**3,777**	**10,684**	**5,771**	**4,167**	**3,138**	**3,239**	3,000
Mexico	57,488	83,705	76,384	82,480	58,586	114,235	121,607

[a] Data not available.
[b] Included under Austria.
[c] First six months; for second six months see Poland.
[d] See Poland.

[6] Subsidiary of Compañía minera de Peñoles (S. A.).
[7] Subsidiary of American Metal Co. (Ltd.).

World's production of lead, 1913, 1918–1923—Continued

Country	1913	1918	1919	1920	1921	1922	1923
Poland:							
Upper Silesia	(e)	(a)	(e)	(e)	(e)	f 8,325	(a)
Other Poland	(e)	(a)	636	1,500	1,010	1,000	(a)
Rhodesia	295	9,935	12,859	14,836	17,969	20,829	11,197
Rumania	(a)	(a)	544	601	582	477	(a)
Russia	1,000	(a)	(a)	(a)	(a)	(a)	(a)
South America	2,476	4,781	6,565	6,264	4,664	6,082	5,897
Spain	198,829	169,709	125,721	175,196	135,881	119,451	127,514
Sweden	1,235	2,241	827	863	513	315	200
Tunis		16,533	5,860	11,407	12,225	14,552	14,090
Turkey	13,900	2,500	1,000	1,000	8,345	5,400	1,400
United States (refined)	385,643	503,702	391,982	440,221	367,718	437,845	515,395
Yugoslavia	(b)	(a)	5,727	5,099	4,828	8,497	(a)
Known production	1,150,000	1,140,000	859,000	927,000	883,000	1,071,000	1,118,000

[a] Data not available.
[b] Included under Austria.
[e] See Germany.
[f] Second six months; for first six months see Germany.
[g] Included under Russia.

IMPORTS AND EXPORTS

The following tables were compiled from the records of the Bureau of Foreign and Domestic Commerce by J. A. Dorsey, of the United States Geological Survey.

Lead remaining in warehouse in the United States, December 31, 1919–1923, in pounds

[Stated in the form in which the material was entered for warehouse]

	1919	1920	1921	1922	1923
Ore	29,543,811	32,923,299	13,679,465	10,470,144	76,031,259
Base bullion	61,408,873	69,517,026	24,692,350	7,076,544	80,306,856
Pigs, bars, and old	468,154	2,644,576	693,440		5,234,475

Lead imported for consumption in the United States, 1919–1923

Year	Lead in ore [a]		Base bullion		Pigs, bars, and old [b]		Sheets, pipe, and shot		Not otherwise specified	Total value
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value		
1919	4,106,823	$196,363	31,796,693	$1,130,937	10,174,115	$415,094	8,018	$628	$17,187	$1,760,209
1920	13,700,499	908,619	66,816,820	3,340,600	68,901,959	3,887,821	81,396	5,483	21,328	8,163,851
1921	6,842,807	327,046	56,819,980	1,668,410	61,909,094	1,972,716	3,087	140	11,204	3,979,516
1922	[c]23,649,851	812,603	55,859,422	1,815,142	[b]8,563,110	[b] 335,924	6,018	697	12,286	2,976,652
1923	[c]22,420,046	1,190,414	11,124,151	626,201	[b]42,925,265	[b]2,510,466	19,525	4,495	90,027	4,421,603

[a] Includes also lead in matte beginning Sept. 22, 1922.
[b] Includes also imports of antimonial lead, antimonial scrap lead, babbitt metal, solder, etc., beginning Sept. 22, 1922.

Type metal imported for consumption in the United States, 1919–1923

Year	Type metal		Lead content	
	Pounds	Value	Pounds	Percentage
1919	13,394,803	$816,642	11,000,498	82.1
1920	29,887,353	1,349,495	25,761,543	86.2
1921	38,971,351	1,191,553	30,706,845	78.8
1922	43,365,120	1,082,832	32,785,042	75.6
1923	(a)	(a)	7,353,463	(a)

[a] Figures not available.

General imports of lead into the United States, 1919–1923, by classes, in pounds

Year	Lead in ore	Lead in base bullion	Pigs, bars, sheets, and old	Total lead content
1919	19, 573, 856	112, 024, 518	10, 214, 753	141, 813, 127
1920	29, 488, 816	96, 103, 603	71, 437, 108	197, 029, 527
1921	14, 234, 039	71, 733, 838	62, 602, 534	148, 570, 411
1922	24, 474, 481	124, 074, 465	7, 101, 623	155, 650, 569
1923	66, 882, 850	161, 496, 495	42, 198, 848	270 578, 193

General imports of lead into the United States, in ore, base bullion, and refined, 1919–1923, by sources, in pounds

Year	Canada	Mexico	South America	Europe	Other countries	Total
1919	10, 391, 115	125, 541, 614	5, 504, 416	89, 840	286, 142	141, 813, 127
1920	8, 199, 234	131, 815, 278	7, 085, 351	38, 766, 504	11, 163, 160	197, 029, 527
1921	8, 127, 158	106, 406, 238	2, 381, 365	30, 224, 701	1, 430, 949	148, 570, 411
1922	8, 663, 236	141, 216, 136	3, 803, 478	1, 454, 384	513, 335	155, 650, 569
1923	11, 399, 671	242, 352, 788	5, 300, 161	11, 004, 938	520, 635	270, 578, 193

The high price of lead shortly before and during the World War made it profitable to export domestic lead. Beginning in March, 1914, the exports soon reached large quantities, but they declined rapidly after the war.

Refined lead, made from domestic ores, exported from the United States, 1914–1923

Year	Short tons	Value	Year	Short tons	Value
1914	58, 722	$4, 501, 674	1919	10, 510	$1, 471, 256
1915	88, 306	7, 928, 518	1920	2, 730	462, 223
1916	100, 500	13, 494, 065	1921	1, 624	177, 926
1917	53, 688	9, 560, 598	1922	5, 823	604, 605
1918	41, 831	5, 889, 381	1923	1, 999	260, 487

The lead of foreign origin which has been smelted, refined, or manufactured in this country and then shipped abroad is shown below.

Foreign lead exported from the United States, 1919–1923

Year	Exported from warehouse			Exported in manufactures with benefit of drawback (pounds)
	Pigs, bars, and old [a]		All other manufactures	
	Pounds	Value		
1919	81, 951, 396	$4, 536, 273	$44	3, 872, 130
1920	34, 725, 501	2, 570, 535	35, 146	12, 350, 794
1921	50, 000, 259	2, 284, 107	613	18, 738, 927
1922	64, 709, 305	3, 177, 360	146	11, 354, 070
1923	97, 471, 326	5, 195, 256	[b]	25, 052, 107

[a] Since July 1, 1915, the Bureau of Foreign and Domestic Commerce has classed all foreign lead smelted or refined in this country and exported as "domestic exports of pigs, bars, etc., produced from foreign ore." The above figures include also the exports of foreign lead imported in the form of pigs and bars.

[b] Not separately classified in 1923.

Domestic and foreign pig lead exported from the United States, 1922–23, by destinations

[Figures in parentheses are not duplicated in the totals]

Destination	Domestic		Foreign	
	Short tons	Value	Short tons	Value
1922				
Asia	305	$36,870	184	$17,140
Japan	(246)	(30,315)	(56)	(4,536)
Philippine Islands	(38)	(4,143)	(6)	(738)
Australia and Oceania	1	110		
Canada	337	43,559	150	17,701
Cuba	84	12,079	5	587
Europe	3,819	379,504	28,763	2,824,779
Denmark	(112)	(11,200)	(364)	(34,227)
France	(1,737)	(175,311)	(10,678)	(1,029,605)
Germany	(594)	(56,286)	(6,947)	(675,543)
Great Britain	(1,374)	(136,550)	(8,281)	(844,967)
Netherlands	(1)	(142)	(1,681)	(161,881)
Mexico	78	10,634	20	1,707
South America	1,120	110,649	3,231	315,269
Argentina	(537)	(47,143)	(698)	(60,802)
Brazil	(456)	(45,027)	(2,286)	(229,882)
Uruguay			(179)	(16,008)
Panama	1	169		
Other countries	78	11,031	2	177
	5,823	604,605	32,355	3,177,360
1923				
Asia	124	12,950	2	144
Japan	(112)	(10,976)		
Philippine Islands	(8)	(1,104)	(2)	(144)
Australia and Oceania				
Canada	126	23,594	1	128
Cuba	104	15,313	62	6,725
Europe	690	80,852	45,547	4,843,659
Denmark			(224)	(24,034)
France	(336)	(36,964)	(10,335	(1,078,051)
Germany	(a)	(17)	(6,611)	(685,831)
Great Britain	(185)	(25,171)	(21,248)	(2,316,482)
Netherlands	(112)	(12,322)	(4,348)	(460,457)
Mexico	96	17,821	48	6,047
South America	743	90,669	3,074	338,329
Argentina	(384)	(41,602)	(843)	(94,665)
Brazil	(257)	(32,323)	(1,942)	(211,433)
Uruguay	(34)	(3,829)	(284)	(31,553)
Panama	58	9,254	(a)	42
Other countries	58	10,034	2	182
	1,999	260,487	48,736	5,195,256

[a] Less than 1 ton.

CONSUMPTION

Apparent consumption of refined primary lead in the United States, refinery stocks disregarded, in short tons, 1919–1923

	1919	1920	1921	1922	1923
Supply:					
Stock in bonded warehouse Jan. 1	472	234	1,322	347	
Imports of pigs, bars, and old	5,107	35,719	31,301	3,551	21,099
Production	482,220	529,657	448,589	532,662	618,322
	487,799	565,610	481,212	536,560	639,421
Withdrawn:					
Exports of foreign lead—					
From warehouse	40,976	17,363	25,000	32,355	48,736
In manufactures, with benefit of drawback	1,936	6,175	9,369	5,677	12,526
Exports of domestic lead	10,510	2,730	1,624	5,823	1,999
Stock in bonded warehouse Dec. 31	234	1,322	347		2,617
	53,656	27,590	36,340	43,855	65,878
Apparent consumption	434,143	538,020	444,872	492,705	573,543

CUSTOMS DUTIES ON LEAD

In the chapter on lead in Mineral Resources for 1922 there was a tabular comparison of the duties on lead in ore and as metal imposed in the tariff acts of 1909, 1913, and 1922. The tariff act of 1922 contains the following paragraphs relating to lead ore and lead in metallic forms:

Par. 392. Lead-bearing ores and mattes of all kinds, 1½ cents per pound on the lead contained therein: *Provided*, That such duty shall not be applied to the lead contained in copper mattes unless actually recovered: *Provided further*, That on all importations of lead-bearing ores and mattes of all kinds the duties shall be estimated at the port of entry and a bond given in double the amount of such estimated duties for the transportation of the ores or mattes by common carriers bonded for the transportation of appraised or unappraised merchandise to properly equipped sampling or smelting establishments, whether designated as bonded warehouses or otherwise. On the arrival of the ores or mattes at such establishments they shall be sampled according to commercial methods under the supervision of Government officers, who shall be stationed at such establishments and who shall submit the samples thus obtained to a Government assayer, designated by the Secretary of the Treasury, who shall make a proper assay of the sample and report the result to the proper customs officers, and the import entries shall be liquidated thereon. And the Secretary of the Treasury is authorized to make all necessary regulations to enforce the provisions of this paragraph.

Par. 393. Lead bullion or base bullion, lead in pigs and bars, lead dross, reclaimed lead, scrap lead, antimonial lead, antimonial scrap lead, type metal, Babbitt metal, solder, all alloys or combinations of lead not specially provided for, 2½ cents per pound on the lead contained therein; lead in sheets, pipe, shot, glazier's lead, and lead wire, 2⅜ cents per pound.

PRICES AND VALUE

Lead was quoted for immediate delivery in New York at the beginning of 1923 at 7.23 cents a pound. The price rose to 8.6 cents in March, dropped to 6 cents by the middle of July, and after a sharp recovery to 6.65 cents in August remained nearly stationary until December, when a sharp rise brought it to 8.12 cents at the end of the year.

The average quoted price of lead for prompt delivery at New York for the year was 7.4 cents a pound, as compared with an average quoted price of 5.7 cents in 1922. The average selling price, figured on the total sales during the year, was 7 cents, as compared with 5.5 cents in 1922. The average selling price is used in calculating the value of lead produced from domestic ores in the United States.

Prices quoted on lead by the American Smelting & Refining Co. in 1923, in cents a pound

Jan. 9 7.40	May 9 7.25	July 27 6.50
Jan. 10 7.50	June 21 7.00	Aug. 27 6.75
Jan. 22 7.75	July 2 6.65	Sept. 13 6.85
Jan. 23 8.00	July 3 6.50	Oct. 25 6.75
Feb. 23 8.10	July 5 6.35	Nov. 13 6.85
Mar. 1 8.15	July 6 6.25	Dec. 1 7.00
Mar. 2 8.25	July 9 6.10	Dec. 5 7.25
Apr. 19 8.00	July 10 6.00	Dec. 19 7.40
Apr. 28 7.75	July 23 6.25	Dec. 29 7.50
May 3 7.50		

The London price of lead ranged from about 2 to about 3 cents lower than the New York price through the first half of the year,

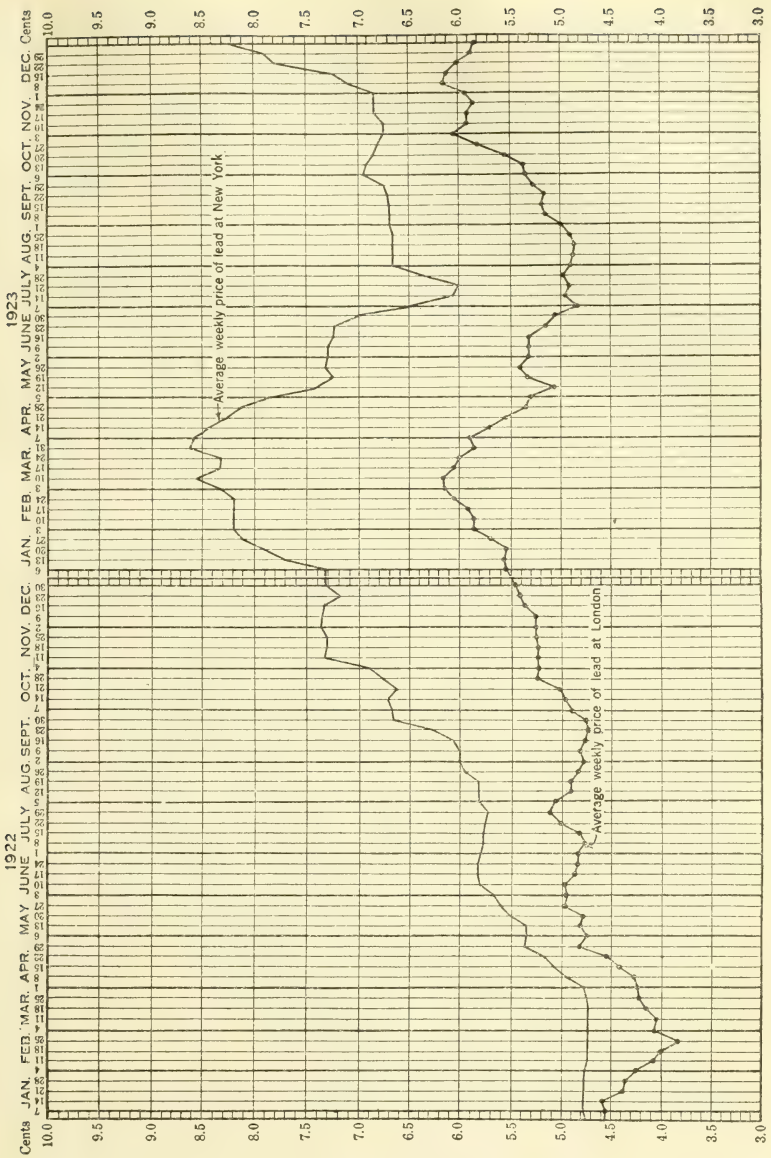

FIGURE 5.—Average weekly quoted price of lead at New York and London, 1923, fluctuations in exchange being taken into account

but in July the decline in price at New York left scarcely more than a cent difference in the price in the two markets. In November and early December the rise in lead at London brought the two markets within less than a cent of each other, but by the end of the year the spread was equal again to more than the tariff differential, 2½ cents a pound. These facts are shown in a striking way by the graphs in Figure 5, which take into account the fluctuations in exchange and show that the London market was more responsive to trade conditions than the New York market.

As stated on page 129, the value of the refined lead produced in the United States from domestic ores in 1923 was $76,138,000 at the average price of refined lead, as compared with $51,562,000 at the average price in 1922, a gain of 48 per cent.

MANGANESE AND MANGANIFEROUS ORES

By Helena M. Meyer

INTRODUCTION

The year 1923 marked an interesting period in the history of the manganese industry, affording the first chance for a demonstration of what domestic operators would produce under tariff stimulation. Although the tariff became effective September 22, 1922, there was not sufficient time before the end of that year to indicate whether or not a large increase in production would take place—in fact, the shipments in 1922 were slightly lower than those in 1921. In 1923 shipments of ore containing 35 per cent or more of manganese increased to more than two and one-third times those of 1922 but were considerably less than tariff advocates hoped they would be and amounted to only a little over 4 per cent of the manganese ore required for the production of ferromanganese in 1918, when steel production was slightly less than in 1923. Sixty-two per cent of the domestic high-grade ore shipped in 1923 was chemical ore from Philipsburg, Mont., and a large part of the remainder was not consumed in making ferromanganese.

The imports of manganese ore in 1923 were less than those in 1918, when domestic production was nearly 10 times as great as in 1923. The domestic production plus imports in 1923 (451,000 gross tons) was less than three-fifths of production plus imports in 1918 (797,000 gross tons). As nearly 95 per cent of the manganese used in industries in the United States is consumed in the production of ferromanganese and spiegeleisen for steel manufacture, the natural assumption from the foregoing comparison would be that considerably less steel was produced in 1923 than in 1918. On the contrary, however, there was an increase in steel production from 44,462,432 gross tons in 1918 to 44,943,696 gross tons in 1923, a total exceeded only in 1917 (45,060,607 tons). The large steel production in 1923 was possible, in spite of the low total of domestic shipments and imports of manganese, mainly because large quantities of manganese ore were imported and stocked at the furnaces prior to September 22, 1922, and because in both 1922 and 1923 more ferromanganese was imported than in any other year since 1913.

In 1923 an average of about $28 a ton was received for domestic manganese ore, compared with about $34 a ton in 1922. The decrease is apparently due to the fact that of the ore shipped in 1923 a large part contained only from 35 to 45 per cent of manganese, whereas in 1922 little of this grade was shipped, most of the ore containing 50 per cent or more.

The tariff brought out shipments of high-grade ore from mines in Alabama, Colorado, Georgia, New Mexico, and Oklahoma, which were idle the year before, and increases from all other States that produced in 1922 except Nevada. Nevada shipped a small quantity of ore in 1922, but no operations were reported in 1923. There were 36 shippers in 1923 from all States, exactly double those reporting shipments in 1922. Montana made the largest output of high-grade ore, producing over twice as much as all other States together. Throughout the dull period between the World War and the time the tariff became effective Montana found a market for the high-grade chemical ore of Philipsburg.

An extensive study of manganese ore reserves in the United States has been completed by the subcommittee on manganese of the committee on foreign and domestic mining policy of the Mining and Metallurgical Society of America, and its report was published in the early part of 1924. The personnel of the subcommittee was as follows: C. M. Weld, chairman; D. F. Hewett, of the United States Geological Survey; J. W. Furness, of the United States Bureau of Mines; Robert Linton, John A. Mathews, J. V. W. Reynders, and Bradley Stoughton.

Although the subcommittee attempted to estimate the reserves of ore at known deposits and in this work had the cooperation of the Geological Survey, the Bureau of Mines, and a number of mine operators and independent engineers, special emphasis was placed on an attempt to estimate future production at assumed prices. In order that the prices throughout a long period should be independent of fluctuations in general commodity prices and therefore be comparable, past production and estimates of future production were based upon "manganese index prices." The manganese index price is the price of the ore in dollars per ton divided by the commodity index number prevailing at the same time. An attempt was made to estimate the amount of manganese ore, containing more than 35 per cent of manganese, which would be produced during three successive years at manganese index prices of $10, $20, $35, and $50 a gross ton for 50 per cent ore. A table, prepared by the subcommittee, showing the annual requirements of manganese ore, based on an annual output of 50,000,000 gross tons of steel, is given below:

Manganese ore required annually for 50,000,000 tons of steel

Grade	Manganese in ore (per cent)	Manganese required (gross tons)	Conversion loss (per cent)	Ore required (gross tons)
Ferromanganese	41.30	220,000	25	710,000
Spiegeleisen	16.00	37,000	30	330,000
Manganese-pig	9.75	43,000	30	630,000

The subcommittee states that according to the best information available, domestic deposits, under the stimulation of an index price of $50 a ton for manganese ore, would be capable of producing ore containing 46,000 tons of recoverable manganese metal for metallurgical purposes the first year, 82,000 tons the second year, and 105,000 tons the third year, and that thereafter production would decline rather than increase. The possible output of chemical

ore, which is not used in steel making and is not included in the above table, is placed at 40,000 tons of ore a year for the three years.

The following estimates of reserves of manganese ore were prepared by the subcommittee. The minimum and maximum figures given correspond in a general way to the terms "probable" and "possible" as commonly used in discussions of ore reserves, although many of the minima include possibilities.

Indicated total reasonably possible reserves of manganese ore of ferro grade (35 per cent or more of manganese), at an index price of $50 a ton, in gross tons, by States

State	Crude		Concentrate		Total		Recoverable manganese	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Alabama			5,000	10,000	5,000	10,000	2,250	4,500
Arizona	60,000	80,000	15,000	20,000	75,000	100,000	33,800	45,000
Arkansas:								
Batesville	160,000	210,000	125,000	165,000	285,000	375,000	132,500	174,300
Western	600	1,000			600	1,000	300	500
	160,600	211,000	125,000	165,000	285,600	376,000	132,800	174,800
California	100,000	160,000			100,000	160,000	40,000	64,000
Colorado	150,000	250,000			150,000	250,000	52,500	87,500
Georgia			85,000	200,000	85,000	200,000	35,700	84,000
Montana:								
Butte, carbonate	135,000	450,000			135,000	450,000	48,600	162,000
Butte, low-grade			75,000	125,000	75,000	125,000	31,500	52,500
Philipsburg	270,000	315,000	70,000	140,000	340,000	455,000	136,000	182,000
Other	400	400			400	400	150	150
	405,400	765,400	145,000	265,000	550,400	1,030,400	216,250	396,650
Nevada	20,000	30,000			20,000	30,000	8,000	12,000
New Mexico	13,500	20,000			13,500	20,000	5,400	8,000
Oregon	1,000	2,000	27,000	50,000	28,000	52,000	11,200	20,800
Tennessee	3,000	5,000	37,000	55,000	40,000	60,000	15,200	22,800
Utah	9,000	12,000			9,000	12,000	4,050	5,400
Virginia			300,000	1,000,000	300,000	1,000,000	126,000	420,000
Others [a]	8,000	10,000			8,000	10,000	3,360	4,200
	930,500	1,545,400	739,000	1,765,000	1,669,500	3,310,400	686,510	1,349,650
Chemical ore	270,000	315,000			270,000	315,000	108,000	126,000
	660,500	1,230,400	739,000	1,765,000	1,399,500	2,995,400	578,510	1,223,650

[a] Idaho, Maryland, New Jersey, North Carolina, Oklahoma, Texas, Wyoming.

The subcommittee drew the following conclusions:

1. The domestic resources of ferro-grade and chemical ores of the United States are so out of balance with the major foreign resources that under natural conditions of international exchange imports of such ores into the United States can be efficiently stopped only at great cost.

2. Should, nevertheless, legislation be enacted which should effect a measurable substitution of domestic for foreign ferro ores, the chief result, aside from the cost, would be the dangerous depletion of reserves, which as it is are totally inadequate for the country's needs.

3. Domestic resources of low-grade reserves, on the other hand, are comparatively adequate. Any effective attempt, however, to force their adaptation to the country's needs beyond the normal development which may be looked for through increase in skill and vigorous educational campaign would result in a cost so enormous as to be quite disproportionate to the purpose to be served.

PRODUCTION

Manganese alloys and ore produced in the United States and imported from principal foreign sources, 1917–1923, in gross tons

Year	Steel (production) [a]	Ferromanganese		Spiegeleisen		Manganese ore				
		Shipments	Imports	Shipments	Imports	Shipments [b]	Total imports	Imports from—		
								Russia	India	Brazil
1917	45,060,607	260,225	41,969	189,241	3,968	129,351	629,972		48,975	512,517
1918	44,462,432	306,076	27,168	263,861	1,969	305,869	491,303		29,275	345,877
1919	34,671,232	198,255	33,022	90,855	27	54,957	333,344	6,916	9,200	246,592
1920	42,132,934	276,594	59,254	103,672	5,234	94,420	[c]599,764	18,762	71,238	421,523
1921	19,783,797	111,374	9,077	69,230	307	13,531	[c]392,606		113,730	262,468
1922	35,602,926	161,612	[d]100,725	70,253	[d] 25,159	13,404	[d]425,000	{ [e] 24,250 / [f] 1,642	[e] 234,598 / [f] 298	[e] 40,595
1923	44,943,696	226,365	[d]113,833	134,086	[d] 23,340	31,500	[d]419,000	[g] 11,670	[g] 25,568	[g] 88,036

[a] According to American Iron and Steel Institute.
[b] Exclusive of small quantities of ore shipped for use in fluxing.
[c] Exclusive of 7,173 tons in 1920 and 8,748 tons in 1921 reported by Bureau of Foreign and Domestic Commerce as manganese ore. The value of this "ore" ranged from $46 to $292 a ton; consequently the Survey believes that the figures represent imports of ferromanganese, spiegeleisen, manganese chemicals, and perhaps some chemical ore.
[d] Prior to Sept. 22, 1922, the Bureau of Foreign and Domestic Commerce reported the gross weight of manganese ore, ferromanganese, and spiegeleisen imported, but since that date has reported only the manganese content. This figure is a Survey estimate of the gross weight of ore or alloy imported. For the figures reported by the Bureau of Foreign and Domestic Commerce, see the tables on pages 154 and 155.
[e] For Jan. 1 to Sept. 21, 1922. Figures represent gross weight of manganese ore imported.
[f] For Sept. 22 to Dec. 31, 1922. Figures represent manganese content of ore imported.
[g] Figures represent manganese content of ore imported.

Manganese ore produced in the principal countries, 1918–1923, in metric tons

Country	Percentage of manganese	1918	1919	1920	1921	1922	1923
North America:							
Canada		399	600	589	62	66	
Costa Rica	37–48	[a] 10,168	[b] 10,148	[a] 3,253	[a] 589	[c]	[c]
Cuba [b]	36–44	84,306	35,887	8,379	35	12,770	9,207
Mexico	40+	2,878	2,794	1,137			
Newfoundland		[c]	[c]	[d] 168	[d] 384	[c]	[c]
Panama [b]	50±	5,696	2			[c]	406
United States:							
Continental (exclusive of fluxing ore)	35+	310,778	55,839	95,935	13,748	13,619	32,006
Porto Rico [a]	35+	1,372	[c]	[c]	[c]	[c]	2,799
South America:							
Brazil [a]	38–50	393,388	205,725	453,737	275,694	340,706	235,831
Chile	40–48	2,358	150	11,633	23	900	[c]
Europe:							
Austria		[c]	5,267	[c f]	[c f]	[c f]	[c f]
Belgium		2,610					[c]
Bosnia-Herzegovina	46	[c]	[g]	[g]	[g]	[g]	[g]
Czechoslovakia		[c]	45,693	50,295	43,541	23,557	[c]
France	30+	9,871	7,016	10,302	3,519	5,220	[c]
Germany	30+	13,567	11,475	7,270	3,385	[c]	[c]
Hungary		[c]	100				[c]
Italy	18–45	31,896	30,841	36,158	11,087	7,890	28,873
Norway		123	22				
Portugal	38–70	[c]	193	925	353	[c]	[c]
Rumania		[c]	[h] 2,755	[h] 3,369	[h] 3,035	[h] 5,392	[c]
Russia [i]	41–48	267,594	22,365	5,243	12,191	51,504	[j] 71,431
Spain	29+	77,714	66,685	21,256	20,098	25,455	28,635
Sweden		16,648	12,400	14,960	6,253	4,528	[c]
United Kingdom	30+	17,736	12,272	13,082	522	254	[c]
Yugoslavia		[c]	[c]	5,327	910	165	5,145
Asia:							
China		[c]	[c]	[a] 25,323	[a] 25,627	[c]	[c]
India	47–52	526,266	546,630	748,259	690,189	482,015	[c]
Japan	50+	56,991	[k] 22,877	[k] 5,474	[k] 3,881	[k] 4,440	[c]

[a] Exports.
[b] Imports into the United States. Data of production and exports not available.
[c] Data not available.
[d] Exports for the year ending June 30 of the year stated.
[e] Less than 1 ton.
[f] Estimated manganese content of manganiferous iron ore produced was as follows: 1920, 9,409 tons; 1921, 13,345 tons; 1922, 19,947 tons; 1923, 24,033 tons.
[g] Included under Yugoslavia.
[h] Year ending Mar. 31 following the year stated.
[i] Exclusive of Georgia and other parts of the Caucasus. The output of Georgia for 1918–1920 is reported as follows: 1918, 152,400 tons; 1919, 54,054 tons; 1920, 91,749 tons.
[j] Operating year, Oct. 1, 1922, to Sept. 30, 1923.
[k] Official figures covering all mines that produced over 375 tons. Complete data not yet available.

Manganese ore produced in the principal countries, 1918–1923, in metric tons—Con.

Country.	Percentage of manganese	1918	1919	1920	1921	1922	1923
Africa:							
Algeria [a]		(c)	(c)	5,250	1,893		661
Egypt		27,498	48,743	77,562	55,065	104,143	132,384
Gold Coast		30,777	35,754	41,628	7,311	(c)	(c)
Morocco (French)	45–48		4,000	4,375	(c)	(c)	(c)
Tunis	42+	830	1,313	1,300	1,500	180	1,153
Union of South Africa	49–55	834	78	61	287	157	393
Oceania:							
Australia—							
New South Wales		6,617	4,726	2,572	3,571	2,436	2,597
Queensland		1,320	20	15	846	68	75
Victoria					10	152	
South Australia		1,097	303	522	1,622	649	171
Western Australia [a]					16	18	(c)
Dutch East Indies		1,450	2,915	4,179	2,093	3,233	(c)
New Caledonia		900	2,309	2,244	4,200	1,083	64
Philippine Islands		650			(c)	(c)	(c)

[a] Exports.
[c] Data not available.

Manganese and manganiferous ore (exclusive of fluxing ore) shipped from mines in the United States in 1919–1923, by States

State	Ore containing 35 per cent of manganese or more			Ore containing 10 to 35 per cent of manganese			Ore containing 5 to 10 per cent of manganese		
	Shippers	Gross tons	Value	Shippers	Gross tons	Value	Shippers	Gross tons	Value
Total, 1919	42	54,957	$1,791,118	24	211,632	$965,660	9	112,303	$352,570
Total, 1920	56	94,420	2,396,235	31	357,279	1,450,518	6	279,687	644,572
Total, 1921	14	13,531	495,097	6	8,439	42,755	3	62,670	147,576
1922									
Alabama				1	475	1,900			
Arizona	2	263	2,572						
Arkansas	9	2,264	42,197						
California	1	(a)	(a)						
Georgia				1	839	(a)	1	194	(a)
Michigan				2	9,644	(a)			
Minnesota				3	305,093	940,311	4	248,560	622,278
Montana	3	9,751	371,245						
Nevada	1	(a)	(a)						
New Mexico				2	28,623	(a)			
Tennessee	1	113	1,636						
Virginia	1	800	(a)						
Wisconsin							1	2,860	(a)
Undistributed		273	37,510			129,569			9,761
	18	13,404	455,160	9	344,674	1,071,780	6	251,614	632,039
1923									
Alabama	1	(a)	(a)	4	694	8,067			
Arizona	1	245	(a)						
Arkansas	8	3,768	73,507	7	4,773	20,047			
California	2	(a)	(a)						
Colorado	3	2,278	41,203	8	18,348	68,204			
Georgia	5	1,502	23,380	11	14,718	80,135	7	15,530	43,711
Michigan				1	20,079	80,517	1	204,700	(a)
Minnesota				4	253,634	880,575	3	499,181	1,406,385
Montana	6	21,916	674,509						
New Mexico	3	179	3,693	3	6,759	17,398			
Oklahoma	1	(a)	(a)						
Tennessee	3	213	5,611						
Virginia	3	987	42,020	3	661	3,685			
Wisconsin							1	353,046	(a)
Undistributed		412	11,050						2,148,231
	36	31,500	874,973	41	319,666	1,158,628	12	1,072,457	3,598,327

[a] Included under "Undistributed." Geological Survey not at liberty to publish.

In the following table is shown the total recorded production of manganese from 1838 through 1923. From 1917 through 1923,

owing to the stimulation of the World War, approximately 1.4 times as much manganese ore containing 35 per cent or more of manganese was produced as during the entire period from 1838 through 1916. Although through 1916 Montana had produced less than 1½ per cent of the total for the country, through 1923 this State had produced over 37 per cent of the total. The nearest rival for first place is Virginia, which had produced over 55 per cent of the country's total through 1916, but only 26 per cent through 1923. Georgia is next, with about 10 per cent; then Arkansas, with 8 per cent; and California, with nearly 7 per cent. Of the five States mentioned two are Eastern, two Western, and one Central. The two Eastern States and the Central State produced the larger part of their total output prior to 1916, but the two Western States produced much the larger part of their output after 1916. Other States that have produced notable quantities are Western States whose output has been made chiefly since 1916.

The subcommittee on manganese already cited states in its report that 710,000 gross tons of manganese ore containing 41.30 per cent of manganese is required for making the ferromanganese needed for the manufacture of 50,000,000 gross tons of steel. The steel production of the United States has not yet reached 50,000,000 tons a year, but in 1923 it was nearly 45,000,000 tons. If from the total shown in the following table as produced by the United States in the 86 years from 1838 through 1923 (1,101,437 tons) is subtracted the output of chemical ore, it will be found that the remainder for making ferromanganese is less than one and one-half times the quantity required for the manufacture of 50,000,000 tons of steel in one year.

Manganese ore (containing 35 per cent of manganese or more) produced[a] in the United States, 1838–1923, in gross tons

State	1838–1916[b]	1917	1918	1919	1920	1921	1922	1923	Total, 1838–1923[b]
Alabama	314	264	709	40	57			(c)	[c] 1,384
Arizona	3,399	14,802	17,612	529	2,402	328	203	245	39,520
Arkansas	57,482	10,140	7,731	2,558	3,445	728	2,264	3,768	88,116
California	22,036	14,196	24,067	11,289	1,733		(d)	(d)	[d] 73,931
Colorado	260	60	4,821	11,166	3,643	490		2,278	22,718
Georgia	99,516	3,614	6,679	48	341			1,502	111,700
Michigan	137								137
Missouri	44								44
Montana	6,555	61,109	199,932	24,993	76,441	11,129	9,751	21,916	411,826
Nevada	345	3,450	19,872	78	1,240		(d)		[d] 25,003
New Jersey			64						64
New Mexico		2,603	3,126		2,053			179	7,961
North Carolina	181	102	315						598
Oklahoma	206							(c)	[c] 206
Oregon			198						198
Pennsylvania	1,113								1,113
South Carolina	1,367	405	100						1,872
South Dakota	19		31						50
Tennessee	3,054	1,996	4,162	328	502	139	113	213	10,507
Texas		25	380						405
Utah	5,177	4,195	5,100						14,472
Vermont	1,625								1,625
Virginia	254,377	12,360	10,928	3,928	2,523	717	800	987	286,620
Wyoming		30	42		40				112
Undistributed	1,198						[d] 273	[c d] 412	[c d] 1,255
	458,405	129,351	305,869	54,957	94,420	13,531	13,404	31,500	1,101,437

[a] Beginning with 1910 figures represent shipments and exclude fluxing ore.

[b] Prior to 1916 some States in some years produced insignificant quantities of manganese ore. Some of these quantities could not be published separately without disclosing confidential information, so they were included with totals for other States. The quantities so included are more or less compensating and are too small to affect State totals materially.

[c] The small tonnages for Alabama and Oklahoma in 1923 may not be shown but are included under "Undistributed" both for 1923 and in the total for 1838–1923.

[d] Tonnages for California in 1922 and 1923 and for Nevada in 1922 are included under "Undistributed" but are shown under the proper State in the total for 1838–1923.

Manganese and manganiferous ore shipped from mines in the United States, 1910–1923, in gross tons

Year	Manganese and manganiferous ores, exclusive of fluxing ore			Fluxing ore containing manganese		
	Ore containing 35 per cent of manganese or more	Ore containing 10 to 35 per cent of manganese	Ore containing 5 to 10 per cent of manganese	Ore containing 35 per cent of manganese or more	Ore containing 10 to 35 per cent of manganese	Ore containing 5 to 10 per cent of manganese [a]
1910	2,258				41,260	19,841
1911	2,457	2,602	82		34,982	6,771
1912	1,664	2,782	117		38,081	10,537
1913	4,048	9,650			41,862	7,891
1914	2,635	60,484			31,182	6,599
1915	9,558	64,204	10,616	55	116,749	4,166
1916	31,474	316,600	81,615		137,253	8,858
1917	129,351	576,608	108,409	54	154,151	21,776
1918	305,869	818,003	236,103		98,160	18,196
1919	54,957	211,632	112,303	365	98,202	11,596
1920	94,420	357,279	279,687		123,970	6,728
1921	13,531	8,439	62,670		22,962	3,028
1922	13,404	344,674	251,614	2,278	27,705	1,666
1923	31,500	319,666	1,072,457	769	40,770	1,004
	697,126	3,092,623	2,215,673	3,521	1,007,289	128,657

[a] Includes ore containing less than 5 per cent of manganese, as follows: 1915, 796 tons; 1916, 1,026 tons; 1917, 141 tons; 1918, 1,684 tons; 1919, 844 tons; 1920, 1,250 tons; 1921, 998 tons; 1922, 117 tons.

The shipments of ferruginous manganese ore (containing 10 to 35 per cent of manganese and exclusive of fluxing ore) decreased from 344,674 tons in 1922 to 319,666 tons in 1923. This decline is due entirely to decreases in shipments from Minnesota and New Mexico, as all other States that produced in 1922 increased their shipments and several others started shipping. The total amount received for ore of this grade in 1923, however, was higher than that received for the larger quantity in 1922, being $1,158,628, compared with $1,071,780, an average of $3.62 a ton in 1923 as against $3.11 a ton in 1922.

The shipments of manganiferous iron ore (containing 5 to 10 per cent of manganese and exclusive of fluxing ore) increased from 251,614 gross tons in 1922 to 1,072,457 tons in 1923, a gain of over 326 per cent. This large increase can not be considered especially significant, however, because although Minnesota's increase from 248,560 to 499,181 tons, a gain of over 100 per cent, was a legitimate increase, the shipments from the Tilden mine of the Oliver Iron Mining Co., in Michigan, and the Ottawa mine of the Montreal Mining Co., in Wisconsin, merely represented a shifting in classification from iron ore to manganiferous iron ore. The shipments from these two mines in 1923, which represent the totals for Michigan and Wisconsin, aggregating 557,746 tons, contained sufficient manganese in 1923 to be classed as manganiferous iron ore instead of as straight iron ore, as heretofore.

Ferruginous manganese and manganiferous iron ores shipped from the Cuyuna district, Minn., 1917–1923, and total, 1913–1923, in gross tons

Mine	Ore containing 10 to 35 per cent of manganese						
	1917	1918	1919	1920	1921	1922	1923
Algoma (Hoch)	[a]84, 125	21, 200	24, 478	[b] 5, 115			
Arko		733	500	2, 044			
Cuyuna Mille Lacs	112, 554	132, 515					
Ferro	([a])	57, 261	14, 556				
Gloria			2, 637	738			
Hillcrest							430
Hopkins		36, 651	5, 849				
Ida Mae (Milford)		5, 134		[b]20, 851			
Joan, Nos. 1 and 4	8, 375	27, 931		8, 500			
Kennedy							
Mahnomen	4, 000	132, 726	11, 472	9, 842		69, 644	74, 247
Mangan, Nos. 1 and 2	52, 290	67, 796	92	10, 979			
Martin		349					
Merritt, Nos. 1 and 2	33, 180	78, 555		33, 239			[c] 24, 387
Portsmouth						38, 000	
Sagamore			79, 248	163, 904		197, 449	154, 570
Sultana	65, 018	64, 158	120	[b] 38, 312			
	359, 542	625, 009	138, 952	293, 524		305, 093	253, 634

Mine	Ore containing 5 to 10 per cent of manganese							Total, 1913–1923
	1917	1918	1919	1920	1921	1922	1923	
Algoma (Hoch)								[a] 165, 710
Arko								3, 277
Cuyuna Mille Lacs		25, 560						477, 050
Ferro								[a] 86, 527
Gloria								3, 375
Hillcrest	9, 590	20, 242			15, 473	4, 100		52, 547
Hopkins								42, 500
Ida Mae (Milford)						870	77, 300	104, 155
Joan, Nos. 1 and 4								44, 806
Kennedy				9, 511				9, 511
Mahnomen	82, 000	175, 648	90, 896	81, 066	41, 057	110, 590	282, 883	1, 209, 071
Mangan, Nos. 1 and 2		4, 679						166, 165
Martin		1, 073						1, 422
Merritt, Nos. 1 and 2								169, 361
Portsmouth				158, 336		133, 000	138, 998	468, 334
Sagamore			7, 324					602, 495
Sultana								202, 978
	91, 590	227, 202	98, 220	248, 913	56, 530	248, 560	499, 181	3, 809, 284

[a] Shipments from Ferro mine included with Algoma mine for 1917. Not reported separately to the Geological Survey.
[b] According to the Iron Trade Review.
[c] According to the Lake Superior Iron Ore Association.

Manganiferous silver ore shipped from mines in the United States, 1917–1923, in gross tons [a]

Year	Arizona	Colorado		Montana	Nevada	New Mexico	Utah
		For fluxing	For other purposes				
1917	32, 409	20, 600	104, 115		122, 872		100
1918	10, 854	24, 931	99, 110		80, 096	475	
1919	1, 964	29, 769	11, 055		77, 815	250	
1920	345	34, 670	11, 056		95, 142	541	
1921		10, 819	924		14, 871	300	
1922		13, 951		6, 656		8, 764	
1923		10, 376	18, 348	3, 596	28, 571		

[a] All used for fluxing except that from Colorado designated "For other purposes."

MANGANESE MINING IN PRINCIPAL STATES

ARKANSAS

By H. D. Miser

The mining of manganese ore in the Batesville district, Ark., was stimulated in 1923 by the increased price paid for ore during the year. Although the total production of 8,541 tons (all grades) was less than that of some preceding years, in each of the three months October, November, and December the production was larger than that of any previous month, even during the World War. The ore produced in 1923 came from dozens of "diggings" in all parts of the district. Only one mine yielded a notable production as a result of the employment of steam shovels and a washing plant for mining and concentrating the ore. Hand jigs were in use at several places, but elsewhere the ore was mined and sorted by hand, and the bulk of the ore for the year was produced by this method.

The following is a list of the shippers who not only produced ore but also purchased it from numerous individual miners:

American Manganese Co.
American Ore Corporation.
Northern Minnesota Ore Co.
W. H. Denison.
W. H. Beatty.
R. S. Hanford.
T. F. Shell.
J. F. Barksdale.
E. C. McComb.

The increased activity of the district has continued into 1924. The shipments during January and February were 43 and 59 carloads, respectively. Also in 1924 manganese ore is being shipped on contracts at 55 cents a unit for ore containing 40 per cent or more of manganese and 52½ cents a unit for ore containing 35 to 40 per cent of manganese.

COLORADO

In 1923 2,278 gross tons of high-grade ore (containing 35 per cent or more of manganese) was shipped from Colorado, almost entirely to the Tennessee Coal, Iron & Railroad Co. In addition 18,348 tons of 10 to 35 per cent manganese ore was shipped during the year for purposes other than fluxing and 10,376 tons of 5 to 35 per cent ore for fluxing.

GEORGIA

In 1923 renewed interest in manganese ore was manifested in Georgia, 5 operators reporting shipments of high-grade ore containing 35 per cent or more of manganese, 11 reporting 10 to 35 per cent ore, and 7 reporting 5 to 10 per cent ore. In 1922 there was only one shipper who reported 5 to 35 per cent ore. Some of the producers in 1923 reported more than one grade of ore, so that the total number of shippers was only 14. Although two States had a larger number of shippers of high-grade material in 1923 and several had larger shipments of each grade, there were more new operators of each grade reported in Georgia during the year than in any other State, and Georgia reported a larger number of shippers in the two lower-grade classes than any other State. Except for two small shipments, Georgia's total production came from the Cartersville district.

MONTANA

Montana has been the largest manganese-producing State in the United States since 1916. In 1923 it produced over twice as much as all the other States together. Montana's ability to continue shipping steadily since the World War has been due to the fact that the ore from Philipsburg is suitable for chemical purposes. During this period, when it has been almost impossible to obtain Russian ore for dry batteries, the Philipsburg ore has firmly established itself in this industry. The Philipsburg chemical manganese ores have made up the bulk of the shipments from that district for some time.

VIRGINIA

In 1923 Virginia shipped 987 gross tons of manganese ore containing 35 per cent or more of manganese, valued at $42,020. These shipments were made by three operators and are compared with 800 tons shipped by one producer in 1922.

The Hy-Grade Manganese Co., under the management of J. Carson Adkerson, Woodstock, Va., continued operations throughout the year at the Mineral Ridge mine, in the Cedar Creek district, Frederick County. The ore is separated by hand into grades at the working faces of the mine and is then transported by trucks and teams to the mill at Strasburg. At Strasburg the ore is carefully tested and uniformly graded, dried by a rotary dryer, and ground and sized according to the purposes for which it is to be used. The product is shipped in bags and barrels to the special markets for high-grade ore.

IMPORTS[1]

Manganese ore imported into the United States, 1922–1923

[General imports]

Country	1922				1923	
	Jan. 1–Sept. 21		Sept. 22–Dec. 31			
	Ore (gross tons)	Value	Manganese content (gross tons)	Value	Manganese content (gross tons)	Value
Africa (British):						
South	5,998	$21,891				
West	22,701	106,223			27,965	$297,376
Argentina					928	20,040
Belgium			528	$18,956		
Brazil	234,598	2,025,505	40,595	469,938	88,036	1,454,790
Canada	60	2,208	67	3,619		
Chile					789	16,772
China	2	46	1	67	1	55
Cuba	12,568	89,677			[a]	137,016
England	448	18,242	1,093	74,429	287	36,375
Germany	41	3,259	52	5,131	146	14,654
Hongkong			1,243	28,677	20	1,020
India (British)	24,250	82,016	298	4,793	25,568	625,299
Java and Madura			205	10,250	6	369
Mexico	500	10,000				
Netherlands					26	1,664
Oceania (French)					[b]	36
Panama	[b]	19			400	5,300
Russia in Europe			1,642	38,180	11,670	262,790
Turkey:						
In Europe	26,561	336,638	1,000	50,000	38,139	914,156
In Asia					3,005	86,798
	327,727	2,695,724	46,724	704,040	[c] 196,986	3,874,510

[a] The imports from Cuba are recorded as 9,062 gross tons of ore in 1923; manganese content not shown.
[b] Less than 1 ton.
[c] Exclusive of the manganese content of Cuban ores.

MANGANIFEROUS ZINC RESIDUUM

Manganiferous zinc residuum containing 12 to 15 per cent of manganese and 40 per cent of iron was recovered, as in former years, from the roasted franklinite concentrates at Franklin Furnace, N. J., and was smelted to spiegeleisen.

Manganiferous residuum, from zinc roasting in the United States, shipped in 1918–1923, in gross tons

1918	146, 796	1921	12, 627
1919	80, 418	1922	81, 333
1920	133, 602	1923	132, 801

FERROMANGANESE AND SPIEGELEISEN

The firms that made or shipped ferromanganese and spiegeleisen in 1923 are listed below (f indicates ferromanganese; s, spiegeleisen):

s American Manganese Manufacturing Co., Dunbar, Pa.
f Anaconda Copper Mining Co., Great Falls, Mont.
f Bethlehem Steel Corporation, Sparrows Point, Md., and Lackawanna, N. Y.
fs Bethlehem Steel Corporation, Johnstown, Pa.
f Electro Metallurgical Co., Niagara Falls, N. Y.
f Jones & Laughlin Steel Corporation, Woodlawn, Pa.
f Lavino Furnace Co., Lebanon and Marietta, Pa.
fs Lavino Furnace Co., Sheridan, Pa.
s New Jersey Zinc Co., Palmerton, Pa.
fs Tennessee Coal, Iron & Railroad Co., Bessemer and Birmingham, Ala.
f United States Steel Corporation, Etna, Neville Island, and Pittsburgh, Pa.
s United States Steel Corporation, Etna, North Braddock, and Pittsburgh, Pa.

Ferromanganese and spiegeleisen shipped from furnaces in the United States, 1919–1923

Year	Ferromanganese		Spiegeleisen	
	Gross tons	Value	Gross tons	Value
1919	198, 255	$27, 093, 816	90, 855	$3, 965, 754
1920	[a] 276, 594	41, 840, 690	103, 672	5, 289, 049
1921	[a] 111, 374	13, 654, 800	[b] 69, 230	2, 838, 692
1922	[a] 161, 612	10, 673, 638	70, 253	2, 162, 836
1923	226, 365	23, 853, 313	134, 086	4, 547, 113

[a] Includes a small quantity of silico-manganese.
[b] Includes a small quantity of silico-spiegel.

Ferromanganese and spiegeleisen imported for consumption in the United States, 1919–1923

Year	Ferromanganese		Spiegeleisen	
	Gross tons	Value	Gross tons	Value
1919	33, 022	$4, 283, 541	27	$1, 018
1920	59, 254	7, 775, 278	5, 234	277, 900
1921	9, 077	888, 419	307	10, 472
1922 (Jan. 1–Sept. 21)	72, 136	6, 125, 469	3, 899	268, 135
1922 (Sept. 22–Dec. 31)	[a] 22, 871		[a] 4, 252	
1923	[a] 91, 066	8, 357, 023	[a] 4, 668	165, 791

[a] Prior to Sept. 22, 1922, figures represent gross weight of the ferroalloy; after that date they represent manganese content of the ferroalloy.

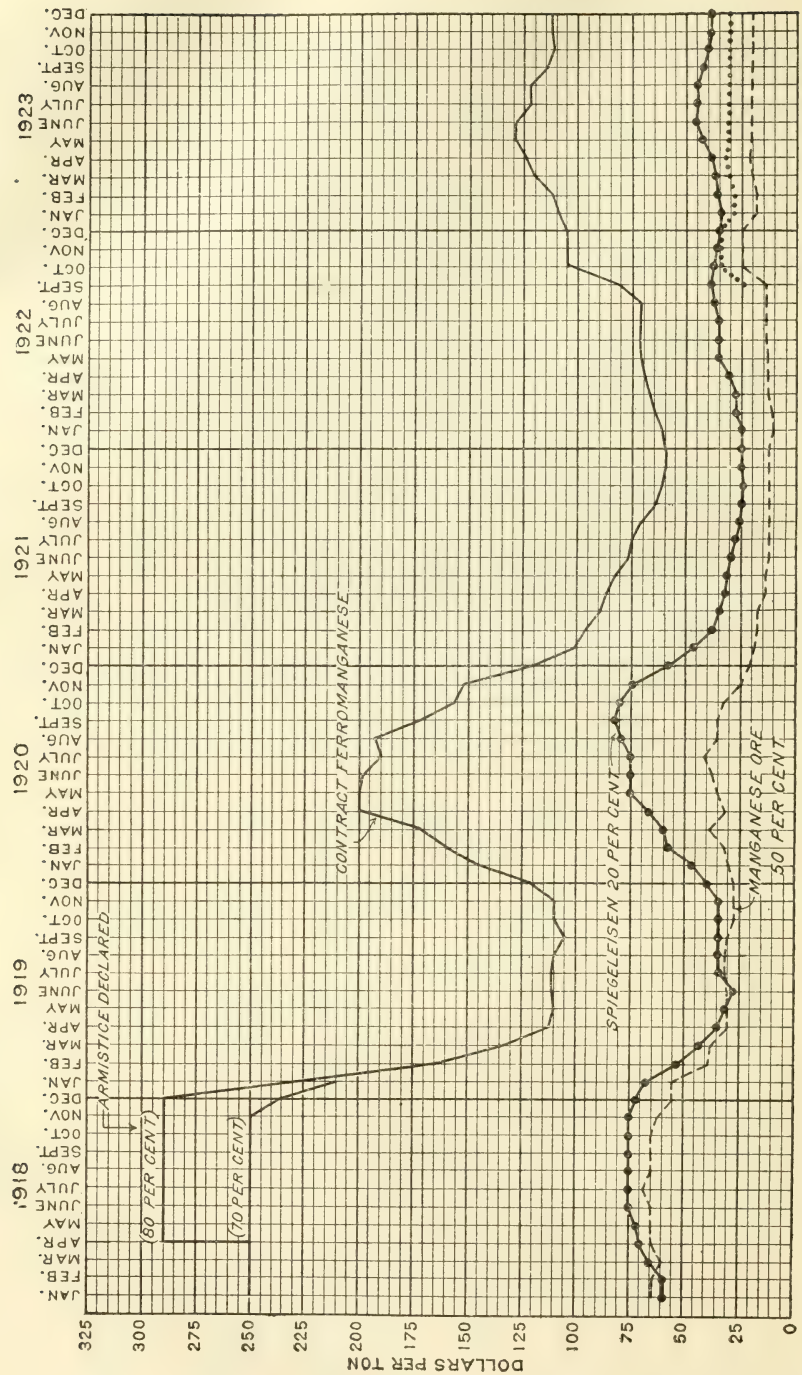

FIGURE 6.—Contract prices of ferromanganese, spiegeleisen, and manganese ore, 1918–1923. The dotted line above the curve for manganese ore from September, 1922, through 1923 represents the additional amount received for manganese ore after the tariff became effective—$11.20 a ton for 50 per cent ore.

The following records of average contract prices of ferromanganese and of spiegeleisen by months for the last five years show a wide range. The ferromanganese prices are prices for material delivered at Pittsburgh; the prices of spiegeleisen are prices at producers' furnaces. (See also fig. 6.) Prices on ferromanganese from May, 1918, to and including January, 1919, are based on 70 per cent of manganese and other prices on 80 per cent; prices on spiegeleisen from April, 1918, to and including June, 1919, are based on 16 per cent of manganese and other prices on 20 per cent. The prices on manganese ore are for material containing 50 per cent of manganese.

Prices per gross ton of ferromanganese, spiegeleisen, and manganese ore in the United States, 1919–1923 [a]

Month	Ferromanganese (80 per cent)					Spiegeleisen (20 per cent)				
	1919	1920	1921	1922 [b]	1923 [b]	1919	1920	1921	1922	1923
January	[c] $212.50	$146.00	$101.00	$61.90	$109.79	[d] $67.50	$46.60	$46.25	$25.50	$34.90
February	165.00	160.00	96.85	65.32	112.29	[d] 52.50	57.60	37.75	28.00	35.75
March	134.00	172.00	89.00	67.82	120.79	[d] 42.50	60.40	34.20	28.00	37.25
April	113.75	200.00	87.50	69.07	124.79	[d] 34.50	66.85	32.00	30.00	39.25
May	110.00	200.00	83.00	72.32	129.79	[d] 31.35	75.00	31.75	35.00	43.00
June	111.75	198.00	76.50	72.82	129.79	[d] 27.50	75.00	29.60	35.25	46.00
July	111.00	190.00	75.00	72.29	122.29	34.00	75.00	27.50	35.00	45.00
August	110.00	193.75	70.75	72.29	122.29	34.00	79.35	26.20	37.00	45.00
September	105.00	172.40	64.75	80.59	114.79	34.00	82.00	25.25	38.00	43.50
October	110.00	156.40	61.65	105.47	112.79	34.00	80.00	24.85	37.75	40.00
November	110.00	153.00	60.00	104.92	113.79	34.00	74.35	25.00	36.80	39.00
December	121.00	120.00	60.00	104.92	113.79	39.00	57.90	25.00	35.50	39.00

Month	Manganese ore (50 per cent)				
	1919	1920	1921	1922 [e]	1923 [e]
January	$55.50	$30.00	$18.75	$10.50	$29.45
February	38.75	38.75	17.50	11.00	29.45
March	37.50	38.75	17.25	12.50	31.70
April	30.00	32.25	14.00	12.75	33.20
May	30.00	35.00	14.00	12.75	32.70
June	30.00	37.50	12.50	13.25	32.95
July	31.25	42.25	12.50	13.50	32.95
August	31.25	35.00	12.50	13.75	32.95
September	30.00	35.00	12.50	14.35	31.70
October	27.50	32.75	12.50	25.50	31.70
November	27.50	25.00	12.50	25.50	31.70
December	27.50	21.25	12.00	25.50	31.70

[a] Iron Trade Review.
[b] Beginning with Sept. 22, 1922, a duty of 1½ cents a pound of contained manganese was placed on ferromanganese imports.
[c] Based on 70 per cent alloy.
[d] Based on 16 per cent alloy.
[e] A duty of 1 cent a pound on the metallic manganese content was placed on manganese ore Sept. 22, 1922. This amounts to $11.20 a ton on 50 per cent ore.

ARSENIC

By V. C. Heikes and G. F. Loughlin

PRODUCTION

Producers of refined and crude arsenic in the United States in 1923 reported an output of 14,902 short tons, of which 631 tons remained in stock or in finished products undistributed. The total sales amounted to 14,271 tons, valued at $2,808,801, or an average of 9.84 cents a pound. The sales of crude arsenic 75 to 95 per cent pure amounted to 1,914 tons, which was sold at an average of 6.58 cents a pound. Factories making weed killer, situated at points where crude arsenic is produced, utilized most of the output, and some of the crude arsenic was sold in small lots to farmers. Manufacturers of plate glass found certain makes of crude arsenic fully as satisfactory as the refined product. The sales of white or refined arsenic 99 per cent or more pure amounted to 12,357 tons, valued at $2,556,874, or 10.35 cents a pound. No production of red arsenic sulphide was reported, and but little of the domestic output in 1922 was sold. No elemental arsenic was produced. The table below includes the production of white arsenic from all sources in the United States since the first output made at Everett, Wash., in 1901. The growth in production is illustrated in Figure 7.

Crude and refined white arsenic produced in the United States and imported, 1901–1923

Year	Domestic sales				Imports	
	Short tons		Value		Short tons	Value
	Refined	Crude	Total	Average (cents per pound)		
1901–1918	[a] 46,239	705	$4,506,786	4.8	[b] 24,939	[b] $2,332,681
1919	[a] 6,029	----------	1,181,684	9.8	[b] 4,389	624,494
1920	10,942	560	2,021,356	8.8	3,740	532,635
1921	3,427	1,359	717,700	7.5	1,669	253,250
1922	8,905	1,122	1,475,229	7.4	1,081	162,494
1923	12,357	1,914	2,808,801	9.8	10,152	1,985,400

[a] Part of the output in 1918 and 1919 was elemental arsenic, but the elemental arsenic produced in 1920 and 1921 is not included in the table, as it was reduced from white arsenic purchased on the market. No elemental arsenic was produced in 1922 or 1923.

[b] Imports for 1901 and 1902 (7,550 tons, valued at $596,580) include also arsenic sulphide. Separate figures not available.

IMPORTS AND EXPORTS [1]

Arsenic compounds (other than white arsenic) imported for consumption in the United States, 1919–1923

Year	Arsenic and sulphide of, or orpiment		Sheep dip		Paris green and London purple	
	Short tons	Value	Pounds	Value	Pounds	Value
1919	2,151	$316,687	146,803	$12,346	18	$14
1920	4,080	684,016	70,168	5,150	772	277
1921	3,343	531,322	61,377	6,362	325	123
1922 [a]	3,815	472,044	70,390	4,877	3,866	741
1923 [a]	1,097	268,311	87,739	5,237	100,781	20,586

[a] Also 41,296 pounds of "acid," valued at $4,195, and 22,487 pounds of "metallic arsenic," valued at $3,484, imported Sept. 22 to Dec. 31, 1922. Not separately classified prior to new tariff. Corresponding imports for 1923 were 166,354 pounds of "acid," $15,597, and 174,415 pounds of "metallic arsenic," $37,314.

White arsenic imported into the United States in 1923, by countries and ports of entry

Country	Short tons	Value		Port of entry	Short tons	Value
		Total	Average (cents per pound)			
Belgium	762	$166,959	10.949	Massachusetts	28	$4,745
France	241	63,360	13.130	Buffalo	794	179,403
Germany	1,883	391,668	10.400	New York	8,018	1,536,816
Greece	373	99,571	13.359	Philadelphia	56	9,655
Netherlands	123	14,806	6.030	Maryland	242	46,328
England	542	144,238	13.314	New Orleans	20	5,600
Canada (Quebec, Ontario).	1,482	335,616	11.325	Galveston	154	18,486
				San Francisco	118	23,946
Mexico	1,893	278,137	7.348	Oregon	45	7,496
Dominican Republic	29	3,568	6.000	Michigan	496	111,432
Brazil	28	5,104	9.280	Ohio	147	33,222
China	122	18,175	7.433	St. Louis	[a]	12
Japan	2,603	450,450	8.652	Wisconsin	34	8,259
Australia	11	1,763	7.954			
British East Africa	30	5,995	9.942		10,152	1,985,400
Portuguese East Africa	30	5,990	9.934			
	10,152	1,985,400	9.778			

[a] Less than 1 ton.

Foreign arsenic and sulphide of, or orpiment, exported from the United States, 1914–1923

Year	Pounds	Value	Year	Pounds	Value
1914	700	$79	1919		
1915	9,776	526	1920	13,799	$1,827
1916	1,761	1,256	1921	23,765	2,835
1917	113,600	15,840	1922	14,290	1,555
1918	80,050	12,017	1923	[a]	

[a] Not compiled at Department of Commerce. Most of the exports consisted of white arsenic, imported and domestic, and went to Canada.

[1] Figures compiled by J. A. Dorsey, of the United States Geological Survey, from the records of the Bureau of Foreign and Domestic Commerce, Department of Commerce.

WHITE ARSENIC

The white-arsenic plants operating in the United States during 1923 were those at Tacoma, Wash.; Toulon, Nev.; Pittsburg, Calif.; Anaconda and Jardine, Mont.; Midvale and Tooele, Utah; Globe, Colo.; and Perth Amboy, N. J. Except those at Toulon, Pittsburg, and Jardine these plants have refined the arsenical dust of smelters whose accumulations represent years of operation. These accumulations of dust have become greatly depleted. During 1923 purchased ores containing appreciable amounts of arsenic were added to the furnace charges, and the demand for arsenic caused changes in equipment at several smelting plants. Late in the year separate roasting plants, arsenic kitchens, and bag houses were added. Most

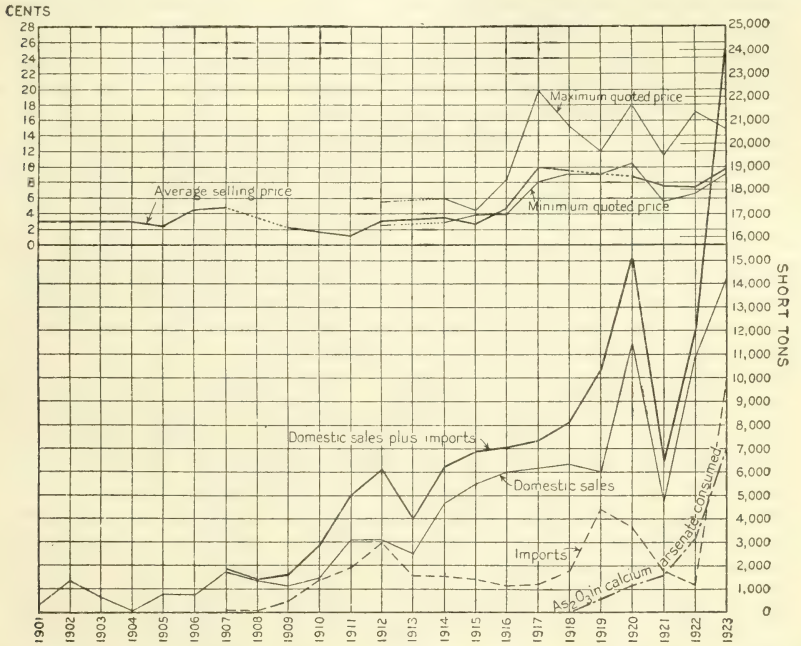

FIGURE 7.—Domestic production, imports, and average quoted price of white arsenic, 1901–1923, also consumption of white arsenic in calcium arsenate.

of the future output of domestic white arsenic is likely to be produced from arsenical ore directly treated for arsenic, either at adequately equipped smelting plants or at independent roasting plants.

About 90 per cent of the total output of crude and refined arsenic in the United States in 1923 came from the reduction works of three smelting companies. Two of these companies operate lead smelters, from which about 70 per cent of the total arsenic was produced; about 20 per cent came from copper smelters, and the remaining 10 per cent from four plants that treat ore primarily for arsenic. A little more than half the arsenic recovered in 1923 was considered a by-product of the smelters.

The principal producer of refined white arsenic is the American Smelting & Refining Co., operating arsenic plants at Tacoma, Wash.,

and at Globe, near Denver, Colo. These two plants receive and refine all the arsenical flue dust from the lead smelter at Murray, Utah, as well as speiss and flue dust from other smelters of the company, and directly treat some purchased ores of arsenic. The United States Smelting, Refining & Mining Co. (Inc.) operates an arsenic refinery at the lead plant in Midvale, Utah, buys crude white arsenic, and treats ore from its own properties directly for the arsenic content. This company makes weed killer (sodium arsenite) from most of its output of crude arsenic and has made calcium arsenate and other insecticides with the refined product but made none of these insecticides in 1923. At Anaconda, Mont., the copper smelter of the Anaconda Copper Mining Co. produces both crude and refined arsenic as a by-product from current flue dust and from a large accumulation of arsenical dust. The last of this accumulation, amounting to about 30,000 tons, was treated in 1923. The International Smelting Co.'s copper and lead plant near Tooele, Utah, has been making crude arsenic from a 10-year accumulation of dust, which will probably be exhausted in 1924.

More arsenic ore was directly treated in 1923 than in 1922, and successful operations were reported at four plants—those of the Toulon Arsenic Co., near Lovelock, Nev.; the Jardine Mining Co., at Jardine, Mont.; the Salt Lake Insecticide Co., at Rowley, Utah; and the National Chemical Co., at Pittsburg, Calif. The last two companies manufacture calcium arsenate. The plant at Rowley makes calcium arsenate from direct treatment of oxidized arsenical ore, and the Pittsburg plant made white arsenic, which was converted into calcium arsenate.

The outlook for 1924 indicates a larger output from the direct treatment of arsenical ore, not only at the four plants named but at the Midvale and Murray smelters in Utah, where roasters and arsenic kitchens have been put in operation on ore carrying a high percentage of arsenic. Besides these improvements, the old Butters cyanidation plant at Martinez, Calif., was converted into an arsenic plant in November, 1923, by the addition of a McDougal roaster by the newly organized Arsenic Products & Refining Co., which has been operating an arsenic mine at Madera, Colo., and is controlled by the Chipman Chemical Engineering Co. The company has in stock considerable custom ore received from Nevada and California.

Before the end of 1923 the Keystone Arsenic Co., at Keystone, S. Dak., started the construction of a concentration mill and had machinery on the ground for a small arsenic plant. Another arsenic plant was planned in the Arkansas Valley of Colorado by the Colorado Insecticide (Inc.), which acquired 200 acres of land in the Goose Creek mining district in Gunnison County, where scorodite and arsenopyrite have been developed.

ARSENIC MARKET IN 1923

DEMAND AND SUPPLY

As shown on page 159, all the crude and refined arsenic produced in 1923 was sold by the producers except 631 short tons. Figures on the production of arsenic compounds are incomplete but suffice to give a fair idea of the distribution of arsenic among different industries.

Calcium arsenate was the leading product. Of the 17 manufacturers, 14 reported to the United States Geological Survey, and their figures check well with those compiled by the Bureau of Entomology, Department of Agriculture, which show a total production of about 34,000,000 pounds and a consumption of 31,000,000 pounds during the "cotton year," from September 1, 1922, to September 1, 1923. The unconsumed remainder was largely sold for use in proprietary mixtures, which were not manufactured. It went mainly to Georgia and South Carolina. This total production was equivalent to about 7,000 short tons of white arsenic. Lead arsenate was made by about 20 firms, 16 of which reported the production of 19,000,000 pounds of powdered lead arsenate, including a little of the compound reported as paste. This output required about 3,000 tons of white arsenic. Paris green, the aceto-arsenite of copper, was made by eight manufacturers, five of whom made about 3,500,000 pounds, requiring about 1,000 tons of white arsenic. A little Paris green was imported. Of sodium arsenite (weed killer) about 1,500,000 gallons was made which contained from 4 to 8 pounds of crude white arsenic to the gallon, requiring about 5,000 tons. Other arsenic compounds amounting to 8,500,000 pounds made by nine producers required 2,800 tons of white arsenic, most of which was converted into arsenic acid. Glass manufacturers used about 2,500 tons of white arsenic. The other compounds reported were cattle dip, magnesium arsenate, arsenite of zinc, Bordeaux mixture, arsenate of soda, and combination insecticides and fungicides. A little domestic white arsenic was exported, principally to Canada.

These incomplete reports account for all but 3,100 short tons of the available supply of white arsenic in 1923, and a considerable part of this remainder may have been consumed by the manufacturers who failed to report. At all events, any stocks of white arsenic held by manufacturers at the end of 1923 could have formed only a moderate margin over the quantity actually needed for current operations, and sales of arsenic compounds, with one exception, also nearly equaled the production. The demands for 1924 must therefore be supplied by new production.

Instability of the market, especially for calcium arsenate, continued to characterize the industry. Early in the year sales were retarded by contradictory information, some of it from apparently authentic sources, as is indicated by the following quotation:[1a]

> The farmers were being charged too high a price, compared with the price of white arsenic; rumors of large supplies of low-priced calcium arsenate and at the same time of general shortage; wide range in price quotations; the availability of proprietary mixtures competing with calcium arsenate.
>
> Under such conditions the farmers delayed or refrained from buying. Furthermore, the weevil season began about three weeks late. Speculators began to cancel contracts, as did others who had entered into ill-advised contracts. A little later the cotton-leaf caterpillar suddenly infested the cotton region, and there was a call for calcium arsenate at any price. It was this sudden demand that nearly exhausted what threatened to be an oversupply of calcium arsenate. Considerable quantities that had found no buyers were reshipped one or more times and finally consumed.

This reshipment was one of several factors in the spread in price between manufacturer and consumer. The average spread was 90

[1a] Report of standing committee on arsenic, representing producers, manufacturers, and Government bureaus, Dec. 10, 1923.

per cent, and one or two shipments have been cited on which the spread was nearly 200 per cent. This unnecessarily high cost to the ultimate consumer will doubtless be reduced with the growth of the industry.

PRICES

The published prices of white arsenic quoted in New York City (see fig. 8) ranged from 15½ cents a pound in January to 11¾ cents in June and the last part of July. The lowest quotation of the year was 9 cents in August. Prices improved as the large consumers commenced to buy, and 15 cents a pound was bid in November. Red arsenic, which was all imported in 1923, was quoted at 13 to 16 cents a pound, but sales were made at 9 to 24 cents a pound. Metallic arsenic sold at 28 to 50 cents a pound. Sodium arsenite

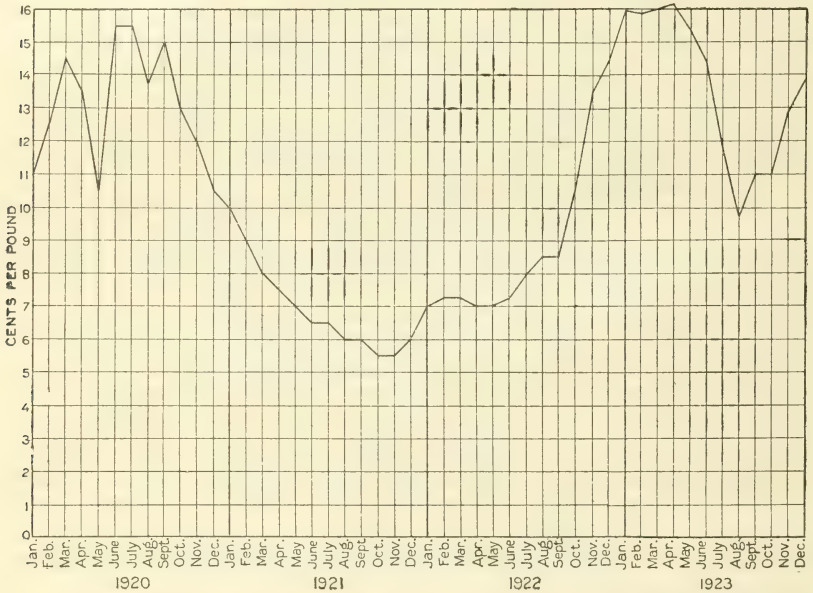

FIGURE 8.—Quoted wholesale prices of white arsenic, 1920–1923. Figures for 1920–1922 from Chemical and Metallurgical Engineering, Dec. 20, 1922, p. 1241; for 1923 from Oil, Paint, and Drug Reporter, weekly quotations.

was quoted at $1 a gallon and sold at 55 to 70 cents a gallon. Lead arsenate, quoted at 18 to 24 cents a pound, sold for 17 to 24 cents; Paris green for 21 to 35 cents; and calcium arsenate, quoted at 12 to 19 cents, for 12 to 17 cents.

The actual sales of white arsenic ranged from 3¼ to 7 cents a pound, the bare cost of production, to 11¼ cents, which most producers considered the lowest price at which they could afford to sell. There was no shortage of white arsenic at any time during 1923, but when prices began to rise those who had not already closed contracts with larger producers bought eagerly. This condition quickly increased the price for all odd lots in the hands of speculators. Current prices of white arsenic based on the prospective needs of the cotton planter have stimulated production for the increase necessary in the manufacture of calcium arsenate, but it is

a mistake to believe that there is a large quantity of arsenic readily available and that the price will revert to the former low levels. The cost of the smelter production of arsenic at the present time is higher as a result of the temporary exhaustion of the richer accumulated arsenical dust and the necessity for purchasing arsenic-bearing ores to increase the output. One writer in a recent publication,[2] basing his argument on 5-cent arsenic, questions the advisability of "going to any great expense in the development of a mine solely for its arsenic content, or in the equipment of a new plant for the recovery of arsenic unless a good profit could be expected."

Manufacturers of white arsenic say that the cost of producing the refined product now averages about 7 cents a pound without allowance for overhead and depreciation, and there has been little incentive to domestic producers to sell at less than 11¼ cents a pound. A drop in the market quotations for arsenic is naturally attributed to a temporary abundance of the imported product, but when this is exhausted the market is again in the hands of the American producer.

Freight charges on white arsenic from western points of manufacture to eastern consumers remained about the same in 1923 as in 1922. Some shippers had difficulty in procuring suitable barrels for white arsenic, to comply with the requirements of the transportation companies, but this defect was remedied.

ARSENICAL ORES

DEVELOPMENT

The reserves of arsenical ores in the Western States were considerably increased during 1923. The large deposit at Gold Hill, Utah, which is mainly scorodite (hydrous ferric arsenate), was developed below the 700-foot level and shown to be more extensive than previous reports had indicated. In the same vicinity another large deposit of arsenopyrite, oxidized to scorodite near the surface, was opened at a depth of 30 feet and followed to a depth of more than 100 feet. These ore reserves at Gold Hill will probably be the source of a large supply of arsenic for many years. The speiss dump at Eureka, Nev., from which 21,094 tons was shipped in 1923, was nearly exhausted at the end of the year, but to offset this loss several new arsenic deposits at Luning, Minden, Chafey, and Carson City were developed.

REVIEW BY STATES

UTAH

The largest immediate source of arsenic in Utah is opened in the old mining district of Clifton, near Gold Hill, Tooele County, about 9 miles east of the Nevada boundary. Most of the ore shipped in 1923 contained arsenic, which until the last two years has been valueless to the producer. Two of the three smelting companies having plants near Salt Lake City control the output from the two largest deposits in the district, but although interested in acquiring these

[2] Eng. and Min. Jour.-Press, Aug. 11, 1923, p. 222.

properties they are not in the market for arsenical ores unless other metals are present. The freight rate to Salt Lake City from Gold Hill on strictly arsenical ores is $1.65 a ton, but if the ore has a greater value in other metallic constituents the rate is increased. Mining costs, which include loading the ore on cars at the Gold Hill mine, are said to amount to $5 a ton on a contract basis.

Prospecting for ore has not been active, on account of the cost of development and the small profit to the producer whose ores carry no gold, silver, copper, or lead. The district, however, is worthy of more prospecting for arsenical ore.

Butler,[3] in a brief description of the geologic conditions, says:

> The sedimentary rocks have been intruded by a body of quartz monzonite which has been exposed by erosion and occupies numerous areas amid the sedimentary rocks. Many of the smaller limestone bodies appear to be underlain at no great depth by monzonite and in fact appear to be sedimentary blocks resting on monzonite. The general arrangement of the sedimentary and intrusive rocks suggests that the present surface is near the more or less irregular top of an extensive body that occupies a large area in the district.

Near Gold Hill the limestone and shale form the eastern flank of the Deep Creek Range and locally reach altitudes of 1,000 to 1,500 feet above the desert plateau. The member of these sedimentary rocks of most interest to the miner is a massive limestone approximately 2,000 feet thick. Overlying the massive limestone is several hundred feet of impure sandy limestone and jasperoidal quartz, followed by about 2,000 feet of shale and sandstone. Mineralization has consisted in the replacement of the limestone at its contact with the quartz monzonite by deposits of silver-lead arsenic ore. The commercial part of the ore body, which is oxidized to the lowest levels, is a cellular mass of scorodite and brownish oxidized mineral (pharmocosiderite?), with small amounts of mimetite, cerusite, and monheimite. In the lower levels bismuth minerals have been found. Small residual masses of the primary ore consist of arsenopyrite and small quantities of galena, pyrite, sphalerite, and chalcopyrite, named in the order of their relative abundance, together with a little gold and silver.

In 1917 the production of ore was confined to the space between the 300-foot level and the outcrop and resulted in the output of 32,023 dry tons of ore. This ore averaged 0.013 ounce of gold and 4.71 ounces of silver to the ton, 2.67 per cent of copper, and 0.58 per cent of lead. The output in 1918 was 15,893 dry tons, containing 0.014 ounce of gold and 5.46 ounces of silver to the ton, 1.32 per cent of copper, and 3.34 per cent of lead.

The principal ore shoot and the only one exploited at the time of the senior writer's visit in 1923 is as a whole lenticular, with horizontal cross sections measuring between 7,000 and 8,000 square feet, but it varies greatly in shape on the different levels. The ore crops out in a very distinctive manner as a heavy brown to black iron gossan, exhibiting a marked contrast with the light-colored limestone. The ore shoot has been developed along its dip of 53° to a depth of 750 feet. The arsenic content of the ore appears constantly large from the 700-foot level to the surface except on the

[3] Butler, B. S., Ore deposits of Utah: U. S. Geol. Survey Prof. Paper 111, p. 473, 1920.

400-foot level, where it is small and spotty. This body of ore measures on the 700-foot level 290 feet in length and averages about 60 feet in thickness, although it has been opened in one place for a horizontal distance of 90 feet. A raise from the 700-foot level was in ore for about 125 feet, and a winze from the same level was in ore at a depth of 50 feet, with indications good for the continuance of the ore for another 100 feet.

According to the record of the mining company, the average analysis of ore shipped from May to October in 1923, most of it mined above the 300-foot tunnel level, was 2.6 ounces of silver, 0.8 per cent of lead, 0.2 per cent of copper, 12.1 per cent of insoluble matter, 24.9 per cent of iron, 0.4 per cent of lime, 1.4 per cent of zinc, 1.4 per cent of sulphur, and 21.3 per cent of arsenic. The sampling of the ore on the 700-foot level gave a higher assay for silver, lead, and iron but less insoluble matter and less arsenic.

The foregoing description of the Gold Hill ore deposit is based on the senior writer's observations and on the reports of several engineers who examined the property during 1923. An average of the most moderate estimates of ore in reserve is 250,000 tons of 20 per cent arsenic ore, which includes ore on the deepest level.

The Last Dollar (Gerster) property, on the west slope of the ridge, about three-quarters of a mile south of Gold Hill post office, is developed by a 100-foot vertical shaft, with a short drift and crosscut driven northeast at the 90-foot level. The shaft was sunk by a lessee seeking scorodite ore. After passing through a greenish shaly deposit of scorodite, ranging in content from 2 to about 15 per cent of arsenic, it was continued in a body of massive arsenopyrite for 42 feet, to a depth of 72 feet, where the arsenopyrite changed to a mixture of arsenopyrite, galena, pyrite, and sphalerite in a quartz gangue. Below these sulphides scorodite of commercial grade and arsenopyrite continued to the bottom of the shaft and in the drift from the 90-foot level. Possibly 50,000 tons of 20 per cent arsenic ore was opened through this development at the end of 1923.

MONTANA

The Jardine mine, in the Sheepeater district, Park County, Mont., within 3 miles of the Yellowstone National Park, is an old one, and until the present company commenced operations, a few years ago, so-called free-milling ore was principally sought and the base ore containing arsenopyrite was neglected.

The ore deposits of the Jardine Mining Co.[4] occur as lenses in mineralized shear zones in folded pre-Cambrian schist. These zones are approximately parallel to the schistosity and also to the original bedding. The general strike of the mineralized zones is north, but here and there they make rather abrupt turns, which conform to changes in the schistosity. The dips range from nearly horizontal to nearly vertical but in the principal stopes are mostly from 20° to 35° W., in general parallel to the slope of the mountain side.

The mineralizing solutions are believed to have ascended along certain permeable planes of schistosity. The deposits were formed largely by replacement of the soft schist, although there is also evi-

[4] Personal communication from H. C. Bacorn, Jardine, Mont.

dence of the filling of open spaces by quartz. Paralleling some of the ore bodies, and in fact including some of them, is a very hard and dense rock (quartz-biotite schist), called "diorite" by the miners. Many faults, varying in age and magnitude, intersect the ore bodies; and although the displacements are generally small some of the structural problems due to the faulting and the folding are unusual and puzzling.

The metallic minerals, named in the order of their abundance, are quartz, arsenopyrite, pyrite, scheelite, and gold. The gold occurs most abundantly with the sulphides.

The ore bodies mined may be divided into three types—large masses of decomposed iron-stained schist which carry small particles of arsenopyrite and gold; high-grade arsenical ore in which large crystals of arsenopyrite occur embedded in the "diorite" above mentioned; and siliceous ore consisting almost entirely of quartz but carrying paying quantities of gold and a small percentage of arsenopyrite. The ore bodies occur in lenses in the mineralized zones. Individual lenses range in length from 300 to 800 feet and in width from 50 to 200 feet, with stoping widths of 3 to 20 feet. These lenses pitch at a very low angle to the north, with one exception where the pitch of the ore body is at a very low angle to the south.

These ore bodies have been developed by several open pits and by 24 tunnels, which lead to over 5 miles of crosscuts and drifts. All workings at the north end of the mine are connected with a gravity tramway, and those in the southern portion are connected by transfer chutes with a horse tram. Open cuts are mined by both the glory-hole and the stripping methods. Underground stopes are supported by stulls, square sets, or timber cribbings according to the nature of the ground.

In the early development of the property many of the drifts were put through bodies of base ore that were not mined, the free-milling ore being preferred. The free-milling ore always contained a little gold-bearing arsenopyrite, which when treated by amalgamation alone gave poor results. Cyanidation was tried on the unroasted mill tailing, but the recovery of gold was not materially increased. Before the recovery of arsenic was considered the present operators constructed a small experimental concentrator and afterward built a larger mill equipped with improved concentrating tables, a Richard-Janney classifier, Callow tanks, and an Allis-Chalmers ball mill for regrinding the middlings. The new mill was designed to treat daily 140 tons of ore containing $7.50 a ton in gold and 5 per cent of arsenic. Mill records show that from the commencement of operations to the present time 21.9 per cent of the gold saved was recovered by amalgamation and 78.1 per cent in the concentrates. The total mill recovery averages 85 per cent. More than 5,000 tons of arsenopyrite concentrate was shipped to the end of 1922, containing 2 to 3 ounces of gold to the ton, with an excess of 23 per cent of iron over silica, which, with 38 per cent of arsenic and 20 per cent of sulphur, received a low smelting rate, averaging not more than $1 a ton.

As a consequence of the high price of arsenic an arsenic plant costing $12,000 was constructed in January, 1923, consisting of a reverberatory furnace connected with a dust chamber and a series

of 27 arsenic kitchens 6 by 8 feet in section and 165 feet long connected to a large stack, the top of which was built 250 feet higher than the furnace. On April 15, after 30 days' operation, 75 tons of crude white arsenic was taken from the kitchens and sold at 14½ cents a pound, which was near the highest price of the year. The calcined concentrate containing gold with a high average percentage of iron over silica was shipped to East Helena. The reverberatory furnace treated daily 15 tons of concentrate from which 4 tons of white arsenic 95 per cent pure was recovered. Ordinarily there is enough sulphur in the concentrate to furnish the necessary fuel, but for the first firing of the reverberatory furnace ordinary mine-run coal was used, and the product, which was not white, was put through a coke-fired furnace and refined to a purity of 99.1 per cent and made perfectly white. According to the annual printed report of the company,[5] 773,091 pounds of white arsenic was sold in 1923 at an average price of 10.7 cents a pound on board cars. This price was equivalent to 11.6 cents a pound f. o. b. New York.

Improvements and additions to the mill and arsenic plant, started before the end of 1923, were expected to increase the daily capacity of the mill from 140 to about 175 tons of ore. The changes contemplate replacing the reverberatory furnace with a 16-foot 6-hearth McDougal furnace and hopper-bottom kitchens, to which will be connected the bag house constructed during the year, containing 48 woolen bags, each 18 inches in diameter and 30 feet long, through which the gases are forced by a large fan. The bag house, constructed of concrete, is 17 feet wide, 22 feet long, and 45 feet high. The whole equipment is contained in a building 100 feet wide, 150 feet long, and 100 feet high from the lowest floor to the roof, and ample room is available for grinding, barreling, and handling the arsenic as well as for all operations incident to the process. The printed report of the company states that 44,429 tons of ore were treated in 1923 with a recovery value of $7.56 a ton for its gold and arsenic, the mining and milling cost of which was $5.11 a ton, which includes 71 cents a ton chargeable to the operation of the arsenic plant.

Elsewhere in Montana prospecting for arsenic ores has been active chiefly at Rimini, Lewis and Clark County, and at Wickes, Jefferson County. A little development was reported in the Crevasse district, Park County.

SOUTH DAKOTA

Development of the Ida Florence and Bullion mines, on the Liberty lode, 1½ miles from Keystone, S. Dak., was recently begun. An old shaft 300 feet deep sunk on the Ida Florence property in the early days was unwatered to the 200-foot level. Arsenopyrite in a quartz vein in schist is the principal gold-bearing mineral. The ore is said to average $5 a ton in gold and contains 12 per cent of arsenic. The ratio of concentration is 3½ to 1. A 10-stamp mill with concentrators was reported (February, 1924) to be in operation, and construction material was at the mine for an arsenic plant.

[5] Jardine Mining Co. Ann. Rept. for year ending Dec. 31, 1923.

ALABAMA

Interest was shown during the year in certain veins in adjacent parts of Randolph and Clay counties, Ala., near Cragford. These veins are distributed through at least four townships. They cut slate or phyllite and were worked for gold years ago. The gold was obtained mostly by panning and by concentrating the oxidized free-milling ore, but operations ceased at ground-water level, where the oxidized ore passed into sulphides containing considerable arsenopyrite.[6]

According to G. R. Mansfield, who visited the district early in 1924, the veins are lenticular to irregular masses of quartz and pegmatite which strike about N. 35° E. and dip 35° SE. The arsenopyrite, accompanied by minor quantities of pyrite, chalcopyrite, and galena, occurs in the veins as masses and disseminated grains but is commonly localized between relatively pure quartz and wall rock. The workings, nearly all shallow pits, were filled with water and afforded little opportunity for inspection. The arsenopyrite that could be seen in place consisted principally of layers from 1 to 3 or 4 inches thick, but more promising material lay on the dumps and gave the impression that the ores were worthy of further exploration as to tonnage and adaptability to concentration. Single ore shoots may be small, but it remains to be seen whether several shoots can be profitably worked to supply a concentrator and roasting plant. The rolling topography and the proximity of the district to the Alabama, Birmingham & Atlantic Railway and to hydroelectric power are favorable factors, though the shallow-water level is likely to add materially to costs of operation. Conclusions similar to Mansfield's are expressed in a preliminary report on these deposits by G. H. Clark, a mining engineer of Birmingham. The deposits are held under option by two or three persons. If they can be successfully developed, the white arsenic from them may find a local market at the new plant of the Gulf States Chemical & Refining Co., at Montgomery, Ala. This plant, using the Kennedy electrolytic process, was to be completed in the spring of 1924, and the company expected to purchase white arsenic in the open market.

WORLD'S PRODUCTION

The foreign production of white arsenic in 1923, stimulated by high prices, closely followed the domestic production, and according to American consular reports considerable arsenic was shipped to brokers in the United States to be held for the best market. The market readily absorbed both the imported and domestic white arsenic, and the supply was adequate for all purposes. Imports of calcium arsenate, which were small in 1923, are not likely to develop very rapidly in excess of foreign requirements.

All available figures on the production and resources of foreign countries are compiled in the following table:

[6] The gold deposits are described in Alabama Geol. Survey Bull. 5, 1896.

World's production of arsenic ore and white arsenic, 1913–1922, in metric tons

Country	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922
Ore										
Australia:										
New South Wales							6	[a]	1,117	[a]
Queensland (arsenical pyrites)					33	202	[a]	[a]	[a]	2,596
Victoria	[b]	[b]	[b]	[b]	[b]	[b]	[a]	[b]	[b]	[b]
Western Australia (ore exported)				11	58	708		1,793	7	1,092
Austria [c]	[b]	[b]	[b]	18	[b]	[b]	[b]	46	54	103
Belgium							[a]	[b]	[b]	[a]
Brazil								[a]	[a]	[a]
Canada	[a]	[a]	[a]	[a]	[a]	[a]	[a]	[a]	[a]	[a]
China (exports of realgar)	508	33	8	431	259	99	225	472	258	549
Chosen	[b]	[b]	[b]	[b]	[b]	[b]	[b]	[b]	[b]	56
France	4,427	250	1,300	1,800	344	728	600	582	580	790
Germany	5,721	4,732	4,085	3,674	6,155	10,998	4,779	6,281	7,033	[a]
Greece					[a]	[b]	[a]	[a]	[a]	[a]
Italy							3		60	450
Japan	[a]	[a]	[a]			830	968	2,173	1,506	2,295
Mexico					[a]	[a]	[a]	[a]	[a]	[a]
Norway						12	20			
Portugal	[a]	[a]	146	[b]	[b]	[b]	62	62	11	[b]
Rhodesia, Southern		[a]				[a]	[a]	[a]	[a]	[a]
Spain (arsenical pyrites)	[a]	[a]	[a]	[a]	[a]	250	150	1,000		
Switzerland	[b]	[b]	[b]	[b]	[b]	[b]	[b]	[b]	39	10
Turkey	88	23					162	14	[b]	200
Union of South Africa					[a]	[a]	[a]	[a]	[a]	[a]
United Kingdom (arsenical pyrites)	36	[a]	428	305	441	485	76	1,197	[a]	360
United States	[a]	[a]	[a]	[a]	[a]	[a]	[a]	[a]	[a]	[a]
White arsenic										
Australia:										
New South Wales							[d]	71	403	296
Queensland					[e] 10	67	59	310	224	406
Victoria	[b]	[b]	[b]	[b]	[b]	[b]	1,041	[b]	[b]	[b]
Western Australia				[d]	[d]	[d]		[d]	[d]	[d]
Austria	[b]	[b]	[b]	[d]	[b]	[b]	[b]	[d]	[d]	[d]
Belgium							50	[f]	[f]	1,008
Brazil								127	127	154
Canada	1,535	1,576	2,174	1,983	2,663	3,230	3,075	2,231	1,353	2,337
China (exports)	21	83	49	59	51	39	58	49	100	30
Chosen	[b]	[b]	[b]	[b]	[b]	[b]	[b]	[b]	[b]	[d]
France	[d]	132	323	874	677	993	735	606	328	425
Germany [e]	1,892	1,637	1,456	1,280	2,081	3,592	1,475	2,077	2,000	2,000
Greece					436	[b]	686	854	768	967
Italy							[d]		[d]	[d]
Japan	21	15	15			245	835	933	1,395	2,044
Mexico					1,285	1,881	2,246	[g] 2,183	785	[h] 272
Norway						[d]	[d]			
Portugal	925	960	859	[b]	[b]	[b]	536	653	268	[b]
Rhodesia, Southern		69				103	220	396	327	451
Spain	47	53	83	73	61	104	42	76		
Switzerland	[b]	[b]	[b]	[b]	[b]	[b]	[b]	[b]	[d]	[d]
Turkey	[d]	[d]					[d]	[d]	[b]	[d]
Union of South Africa					3	13	7	10	2	3
United Kingdom	1,722	2,020	2,536	2,586	2,668	2,387	2,568	2,029	1,049	994
United States	2,280	4,237	4,988	5,430	5,580	5,736	5,469	10,434	4,342	9,096

[a] White arsenic reported.
[b] No data available.
[c] Arsenic slimes, production of one gold mine in Salzburg, with estimated arsenic content as follows: 1920, 7 tons; 1921, 11 tons; 1922, 45 tons.
[d] Ore reported.
[e] Estimated arsenic in ore.
[f] No data of production are available. Declared exports of arsenic from Belgium to the United States were in 1920, 463 tons; in 1921, 485 tons, but no statement was made as to how much of this was of Belgian origin.
[g] Output of Mapimi smelter. Data furnished by company.
[h] Mexican Government figure. The Penoles Co. reports 335 tons shipped in 1922.

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Portugal, 1913–1915, Imp. Mineral Resources Bur., London; 1919–1921, questionnaire by Dept. Mines.
Rhodesia, Southern, Sec. Mines Rept.
Spain, Estadística minera de España.
Switzerland, consular report, Nov. 5, 1923.
Turkey, consular reports, Aug. 1 and Sept. 12, 1923.
Union of South Africa, Dept. Mines and Industries Ann. Repts.
United Kingdom, 1913–1920, Mines and Quarries report; 1921–22, Sec. Mines and H. M. Chief Insp. Mines Ann. Repts.

A questionnaire prepared by the Geological Survey was sent to American consuls with the idea of obtaining further information as to prospective shipments of white arsenic to the United States. The result of the inquiry is briefly given in the following pages, beginning with the countries that lead in production and in shipments to the United States.

PRINCIPAL FOREIGN COUNTRIES

JAPAN

About 25 small mines in Japan are worked for arsenic production alone,[7] some of them in the most primitive way imaginable. Nearly half of these mines are situated in Kyushu, the island southwest of the main island of the Japanese Empire. On the island of Honshu the most important arsenic property is the Takumi mine, which has an arsenic refinery. Refineries are also situated at Saiki and Usuki, and another on the shore of the inland sea near Okayama.

The copper ores of Japan contain a small percentage of arsenic, and most of the output is by-product arsenic from the furnaces of the Sumitomo, Furukawa, Mitsubishi, Kuhara, and Fujita smelters. The arsenic saved at these works is made under conditions similar to those prevailing at copper plants in the United States. The Furukawa company, for instance, has mined in the past a daily output of about 1,000 tons of ore containing 1 per cent of arsenic, but only about 50 tons a month was ultimately recovered.

In Chosen, according to the American consul at Keijo,[8] the output of ore from three arsenic mines in Keisho Hokudo Province is not large. About 60 short tons of ore was treated in 1922 and white arsenic recovered.

In 1923 England was a new buyer in the Japanese arsenic market and shipments were increasing, but the British authorities raised an objection against the form of packing and completely stopped the

[7] Berger, W. F. B. (mining engineer, Denver, Colo.), unpublished notes on the arsenic mines in Japan, 1920.
[8] Miller, R. S., report, Oct. 3, 1923 (U. S. Geol. Survey cons. file, No. 6260).

exportation of arsenic to England until an improvement could be made in the containers.[9]

MEXICO

Arsenic is produced in Mexico solely as a by-product from the smelting of lead ores.[10] Deposits of arsenical ores are known near Velardeña and in other parts of the State of Durango, but the ore is not mined solely for arsenic.

The Compañía minera de Penoles (S. A.), a subsidiary of the American Metal Co., has been the only large producer of white arsenic for several years. This company recovers arsenic from lead ores from its own mines and from custom lead ores smelted at its plant in Monterey. It shipped 500 metric tons in 1921 and 335 metric tons in 1922. Some of the furnace products of the American Smelting & Refining Co. were treated for arsenic in 1923, and the white arsenic was shipped through Tampico to the United States. The Mexican output of white arsenic in 1923, according to official figures published by the Secretaría de Hacienda, was 1,402 metric tons. Of this quantity the Penoles Co. is reported to have shipped 786 metric tons and the American Smelting & Refining Co. 433 metric tons. The latter company's arsenic plant at the new copper smelter at San Luis Potosi did not begin operations in 1923.

In Baja California a small quantity of crude arsenic has regularly been produced and shipped to the United States. The producer, the San Juan Reduction Co., operates a mine yielding gold-bearing arsenopyrite ore, 5 miles east of Triunfo. This ore has been roasted in hand-rabbled furnaces and afterward treated by cyanidation. The Baja California region promises to become an important producer of white arsenic in the later part of 1924 from gold and silver bearing arsenopyrite mined near Triunfo by the Compagnie du Boleo, which expects to chlorinate the calcines.

GERMANY

White arsenic exported to the United States from Germany in 1923 amounted to 3,039 metric tons. The American consul general at Berlin [11] says:

An investigation of the market for arsenic ores and arsenious acids in Germany indicates that, as a source of supply for the United States, no material increase over the present quantity being imported can be obtained in the near future. Arsenic ore is mined in Germany only in the province of Silesia, and the total production in recent years has been around 67,000 metric tons a year. This is not sufficient for the needs of the manufacturers, and considerable quantities of ore are now imported to be worked in Germany. The principal producers of arsenic products are the State mining and smelting works at Mülden-hütten, near Freiberg, Saxony, and the firm of Güttler & Co., Alterwall 76, Hamburg, who control the output of several works. The Saxon producers formerly shipped most of their product to the United States, but their output has been greatly reduced in recent years, and during the first half of 1923 they shipped only about 40 metric tons of arsenious powder to the United States and about half that quantity to other countries. The reduction in output is

[9] Oil, Paint, and Drug Reporter, Jan. 21, 1924, p. 70.
[10] Evans, E. E., Mexico City, report, Aug. 14, 1923 (U. S. Geol. Survey cons. file, No. 6039).
[11] Coffin, William, Arsenic in Germany, report, Oct. 26, 1923 (U. S. Geol. Survey cons. file, No. 6349).

stated to be caused by lack of raw material. The firm of Güttler & Co., of Hamburg, has been shipping regularly white arsenic to the United States and during the past autumn and winter delivered about 200 tons a month. It is stated that the trade is seasonal, and shipments in the spring and summer have been considerably reduced.

The firm of L. C. Marquart (A. G.), at Bouel, in the Rhine provinces, produces arsenic products and has a plant in course of construction in which, it states, it will be able to manufacture calcium arsenate should a profitable market develop in the United States. This firm believes that it will be able to arrange to turn out about 20 tons of the product a month.

The most important source of supply in Germany is undoubtedly the firm of Güttler & Co., of Hamburg, which controls several arsenic mines in Silesia and seems to have at the present time almost a monopoly of trade with the United States, in view of the curtailment of the production of the Saxon refinery. While the production in Germany is at present limited by a shortage of raw materials, it would probably be possible to arrange with Güttler & Co. for an increased output of calcium arsenate if importers in the United States would agree to financing the importation of raw materials, but any operations of this nature should be very carefully conducted, and the American concerns interested should protect themselves in every direction, not only against possible defaults in performance but against possible circumstances of force majeure which may render it impossible for factories in Germany to fulfill contracts.

The American consul at Dresden [12] states that the smelting works near Freiberg find it difficult to procure adequate quantities of raw material, because of the present situation in the purchase of foreign exchange, resulting from the conditions of the money market. It is said that English concerns are able to pay better prices for Chinese and North African ores.

The plant at Müldenhütten is very extensive and is well equipped to treat large quantities of ore, which it receives from Silesia, Greece, Asia Minor, China, and North Africa. The consul says:

> Prior to the World War nine-tenths of the production, mostly red arsenious powder, was exported to the United States. Now the production has diminished so much that the State works are able to fill only in part the orders of their old customers, and this after considerable delay. During the course of this year the State works have exported about 40 metric tons of arsenious powder to the United States and about 20 metric tons to other countries. The shipments to the United States consisted mostly of red arsenious powder and were made through Belgian exporters. Small quantities of white arsenic were also exported through Hamburg agents.

The American consul at Breslau states that the Gewerkschaft Evelinensglueck, of Breslau, under date of November 5, 1923, offered to supply 5 to 10 tons of white powdered arsenic monthly and would consider orders f. o. b. Hamburg. The quality of the arsenic is stated to be first class, and analyses show that it is from 99.7 to 99.9 per cent pure. The imports into Germany in 1923 amounted to 96 tons from the United Kingdom; in 1922 63 tons was shipped from Belgium.

CANADA[13]

During 1923 the bulk of the white arsenic recovered in Canada came from the ores mined at Cobalt and South Lorrain. The concentrates shipped to Tacoma by the Hedley Gold Mining Co. yielded 609 short tons of white arsenic. The Clark Gold Mines Corporation, operating at Montague, Halifax County, Nova Scotia, sent trial shipments of concentrates carrying gold and arsenopyrite to Europe.

[12] Dreyfus, L. G., jr., Arsenic production in Saxony, report, Aug. 1, 1923 (U. S. Geol. Survey cons. file, No. 6037).

[13] Hurst, M. E., A preliminary memorandum of Canadian arsenic resources: Canada Geol. Survey, Mar. 21, 1924.

In Nova Scotia attention is being directed by several mining companies to the recovery of the arsenic contained in former tailings dumps, as well as that in the gold-quartz veins now being mined. It is reported that an arsenic-recovery plant may be erected at Brookfield, in Queens County. Prospects carrying arsenopyrite occur at Meagher Grant, in Halifax County, and at Williamsdale, in Cumberland County.

In New Brunswick arsenopyrite has been found on Stevens Brook, near Bathurst.

In Ontario there are a number of small deposits containing arsenopyrite, especially in Hastings County. The production of arsenic from 1885 to 1903 came largely from this area, in which is the smelter of the Deloro Smelting & Refining Co. (Ltd.). Other partly developed deposits of arsenopyrite occur near Timagami, on the Temiskaming & Northern Ontario Railway, and on Howry Creek, in the Sudbury district. It is probable that the Cobalt and adjoining districts will continue to furnish the bulk of the arsenic production of the province for some time.

In British Columbia the Hedley Gold Mining Co. has so far furnished the entire production. Considerable arsenopyrite occurs at the Aufeas mine, near Hope, and some at other deposits in the vicinity. A number of deposits carrying arsenopyrite, in addition to gold and silver, occur near Smithers and Hazelton, on the Grand Trunk Pacific Railway. One property on Hudson Bay Mountain, near Smithers, is being developed by the Federal Smelting & Refining Co.

In Yukon arsenopyrite-gold veins occur on Dublin Gulch, in the Duncan Creek mining district.

Canadian production, imports, and exports of arsenic, 1922–1923

	1922		1923	
	Quantity	Value	Quantity	Value
Production:				
From arsenical concentrates ..... short tons	518	$21,097	609	$146,765
White arsenic ..... do	2,058	299,940	3,036	731,583
	2,576	321,037	3,645	878,348
Imports:				
White arsenic ..... pounds	44,168	32,520	457,522	66,280
Sulphide of arsenic ..... do	525,246	39,264	7,339	1,244
Arsenate of soda ..... do	7,961	1,402	4,940	475
Exports:				
Arsenic, metallic ..... short tons	222	5,238	588	25,003
Arsenic, not otherwise provided for ..... do	1,367	198,005	1,564	348,646

BELGIUM [14]

At Reppel, in the northeastern part of the province of Limbourg, Belgium, the Société générale métallurgique de Hoboken operates an arsenic plant. White arsenic, red arsenic, arsenic acid, arsenite and arsenate of soda, and calcium arsenate are manufactured. The arsenic is recovered principally from speiss obtained near Hoboken, and other ore is added to the mixture put in the roasters. Most of

[14] Harrington, J. F., Manufacture of arsenic in Belgium, report, Nov. 19, 1923 (U. S. Geol. Survey cons. file, No. 6366).

the white arsenic is exported to America, and most of the other products to South Africa.

GREAT BRITAIN

At Tavistock, Cornwall, the British Mining & Metal Co. (Ltd.) claims that it is possible to produce 2,000 to 5,000 tons of refined white arsenic annually but desires the assurance of a steady market for the product before putting money into the development of mines and metallurgical equipment.

FRANCE [16]

France is rich in deposits of arsenopyrite. Moreover, certain auriferous minerals, especially those of Bellière, Maine-et-Loire, and of Châtelet, Creuse, give arsenious oxide as a by-product in the process of treatment for gold. Mispickel mines are in operation at St.-Martin d'Ollières, at Giat, Puy-de-Dôme, and at Espeluches, Haute-Loire. Realgar mines are situated at Duranus, Alpes-Maritimes, and at Matra, Corsica. The entire output of these mines is used by the Compagnie minière et métallurgique d'Auzon, whose main office is at 34 Rue Tronchet, Paris. This company manufactures arsenic, arsenate of soda, arsenious acid, and red arsenic. Of the five new companies manufacturing arsenic compounds at the time of the signing of the armistice, this is the only one producing at the present time.

The consumption of arsenious oxide is not large in France, amounting to about 1,200 metric tons annually. From 1920 to the middle part of 1922 the production of arsenic was small. During the second half of 1922 the output was 250 tons, and an estimate for 1923 was 1,500 tons. In view of the increased demand, the director of the Compagnie minière et métallurgique d'Auzon believed it possible to increase the production of white arsenic 99 per cent pure to 2,000 tons in 1924 and stated that orders would be entertained for delivery at the rate of 100 to 150 tons a month from January to December.

Duparc [17] describes the occurrence of auriferous arsenopyrite on La Montagne Noire, which is about 17 kilometers north of Carcassonne. The ore occurs in schist and contains about 10 per cent of arsenic, a little copper, and silver.

NORWAY [18]

The Kjorisfjeld arsenopyrite deposit is probably the largest deposit of arsenic in Norway and is but little known. It is situated at a far-off and desolate place in the mountains of Skjomen, in Ofoten, 3,120 feet above sea level, 3 kilometers from the Swedish frontier and 29 kilometers from the harbor. In the summer the only possible means of transportation is the pack horse. The country rock is a coarse-grained potash granite, the overlying mica schist

[16] Thackara, A. M. (American consul general, Paris), French production of arsenic ores and arsenious acid, report, Aug. 31, 1923 (U. S. Geol. Survey cons. file, No. 6090).

[17] Duparc, L., Les filons de mispickel aurifère de la Montagne Noire: Soc. phys. hist. nat. Genève Compt. rend., vol. 40, No. 1, pp. 21–24, Geneva, 1923.

[18] Norsk Arsenmalm og Arsenikfremstilling: Norges Geol. Undersök., No. 106, pp. 30–33, 1922.

being at least 12 kilometers distant. Near the ore deposit are hornblende schist and gabbroic eruptive rocks older than the granite. Still older are some zones of partly dolomitized limestone, in which contact-metamorphic deposits predominate. These deposits contain arsenopyrite, pyrrhotite, chalcopyrite, and magnetite, with traces of sphalerite and galena. The ore body, which is about 7 feet wide, is visible for 90 feet and may extend for 500 feet. A sample across the thickest part of the lode gave 26.5 per cent of arsenic and 11 grams of gold to the ton.

OTHER COUNTRIES

Brazil.—In 1922 the white arsenic exported from Brazil amounted to 52,888 kilograms,[19] valued at 78,400 milreis. A small quantity of white arsenic is recovered annually from the treatment of the gold ores of the St. John del Rey deposit, which contains lollingite and pyrrhotite. A roasting furnace of the Edwards type is used, which is connected with flues, arsenic chambers, and a refinery.

Chile.—Although official statements issued by the Oficina central de estadística fail to show that arsenic occurs in Chile, two deposits are known to exist, and there is reason to believe that others may be found in the northern provinces. The American consul at Valparaiso[20] says:

> In the Province of Copiapo there is an ore deposit running about 20 per cent of yellow arsenic. This mine was worked in a small way some time ago but during recent years has stood idle. The mine is in close proximity to the Government railway running to the port of Caldera, some 50 miles distant. Further data concerning this Copiapo property may be procured from Señor Enrique Weichmann M., Calle Templeman 47, Valparaiso.
>
> Another large deposit of arsenic ore * * * between Santiago and Los Andes * * * belongs to Señor Artemio Múñoz Fölch, Calle Dávila 9509, Santiago. It covers an area of 75 hectares, equivalent to about 160 acres.

Inquiry at the copper smelters indicates that although arsenic occurs in the ores it is present in quantities so minute that it can not be produced profitably in the form of a by-product. From 2,000 to 5,000 kilograms of arsenic acid is imported into Chile annually, principally from Germany.

Greece.—White arsenic, a by-product of the treatment of silver-lead ore, is the only arsenic produced in Greece, according to a report[21] received from the consul in charge at Athens. The present production is about 60 tons a month. Greece has no mines that are operated solely for arsenic. There have been reports that deposits have been found in the Province of Thessaly, northern Greece, but up to the present time no mining has ever been attempted. There is only one smelting company, which has its head office in Paris. Sales are made to England and France at £64 a long ton f. o. b. Laurium. Production was greatly reduced because of a labor shortage, but it was expected that with the approaching demobilization of the Greek army labor would be more pl[illegible]tiful.

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[19] Gaulin, A. (American consul ge[illegible] Rio de Janeiro), letter, July 5, 1923 (U. S. Geol. Survey cons. file, No. 3046).

[20] Makinson, G. A., Arsenic deposit[illegible] Chile, report, Aug. 20, 1923 (U. S. Geol. Survey cons. file, No. 6084).

[21] Ehrhardt, J. G., The arsenic indus[illegible]ry of Greece, report, July 27, 1923 (U. S. Geol. Survey cons. file, No. 6036).

Italy.[22]—Search for arsenic ores has been carried on in Italy only since 1920. Statistics officially reported give 60 metric tons of ore containing 38 per cent of arsenic, valued at about $10 a ton, as the amount produced in 1921. This output came from an antimony mine in the commune of Iglesias, Province of Cagliari, Sardinia. Imports of metallic arsenic into Italy during 1922 amounted to 11 metric tons, valued at 56,760 lire (approximately $2,838). No exports were made during 1922. During the first quarter of 1923 a total of 1.2 tons, valued at 18,275 lire ($914), was imported, and none was exported.

Although official statistics do not mention the production of arsenious oxide, there is a certain exportation of the product from Italy, according to a report by the Ministry of Finances which shows in 1922 exports of 5.3 metric tons, valued at 27,300 lire ($1,365), and imports of 156.4 metric tons, valued at 690,441 lire ($34,522). In the first quarter of 1923 the imports were 44.8 metric tons, valued at 225,465 lire ($11,273).

At present Italy can not be represented as an important source of arsenic supply.

Switzerland.[23]—There is no production of arsenic in Switzerland, and only one deposit of arsenical ore is worked. Arsenic is present in many rocks, but, except at this one deposit, in too small quantities to encourage prospecting. The single ore deposit worked is at Lusin-sur-Salanfe, near Salvan, Bas Valais. About 15 miners are employed, and about 100 tons of the ore was exported to Lyon in 1923. The arsenic mineral is leucopyrite containing 30 to 40 grams of gold to the ton. The only arsenious preparations in use in Switzerland for combating plant pests are arsenic, arsenate of lead, and Paris green, which are imported from Germany.

Austria.—Only one mine in Austria produces arsenical pyrite, according to the American vice consul at Vienna,[24] who gives the name of the operator as the Gewerkschaft Rathausberg of Kockstein, Salzburg. The arsenic ore produced is shipped to the German State smelting works at Freiberg, Germany. As Austria has no domestic smelting plants, it must import arsenic chiefly from Germany.

Czechoslovakia.—The American consul at Prague[25] writes that Czechoslovakia does not export arsenic ores nor arsenious acid but imports both. Arsenic ores are not produced in the Republic. Arsenious acids are imported principally for fighting insect pests, which during 1922 destroyed approximately 25 per cent of the country's forests.

Yugoslavia.[26]—Deposits of arsenic ore are known to exist in numerous localities in Yugoslavia, particularly in Bosnia, Serbia, and Serbian Macedonia. According to Consul Perkins,

> The Bosnian deposits occur at Srebrenik, 20 kilometers north of Donja Tuzla, in northeastern Bosnia, and at Hrmsa, near Kisevo, in central Bosnia. In the

[22] Keen, F. B. (American consul general, Rome), Arsenic ores and arsenious acid in Italy, report, July 10, 1923 (U. S. Geol. Survey cons. file, No. 6035).

[23] Mathee, W. H. (American vice consul, Zurich), Arsenic ores in Switzerland, report, Nov. 5, 1923 (U. S. Geol. Survey cons. file, No. 6342).

[24] Ravndal, C. M., report, Oct. 26, 1923 (U. S. Geol. Survey cons. file, No. 6337).

[25] Winans, C. S., report, Aug. 9, 1923 (U. S. Geol. Survey cons. file, No. 6018).

[26] Perkins, B. A. (American vice consul, Belgrade), Sources of arsenic ores and arsenious acid in Yugoslavia, report, Nov. 12, 1923 (U. S. Geol. Survey cons. file, No. 6335). Wray, D. A., The geology and mineral resources of the Serb-Croat-Slovene State, 1921 (U. S. Geol. Survey cons. file, No. S–3151).

former of these deposits the ore consists of realgar (red arsenic sulphide), which occurs associated with dolomite in a vein about 2 meters thick. In the second deposit the arsenic occurs in the form of realgar and orpiment (yellow arsenic sulphide) associated with fluorspar. The vein, which is about 3 meters wide, occurs in intimate association with intrusive masses of porphyry in the Triassic limestones.

The Serbian deposits are found at Donja Tresnitsa, where realgar occurs associated with lead-bearing veins, and at Crnche, near Krupanj, in the old lead mines of that locality. Arsenical ores are also reported at Rudnjak, Gokchanitsa, Chajetina, Vrba, and Vratarnitsa.

The Serbian Macedonian deposit, known as the Allchar mines, is located at Rozden, between Monastir and Prilep. The nearest railway station, Krivolak, is 30 kilometers distant. The ores here consist of realgar and orpiment in association with antimony ores. The ores are found in stringers and lenses at the junction of crystalline schists and dolomite and limestone. This is the only one of the Yugoslav deposits which has been exploited. Prior to the Balkan and European wars the mines yielded about 500 metric tons of arsenic annually. The ore was sorted at the mine and shipped on mule packs to Saloniki for overseas transshipment. The mine is now doing merely enough work to maintain the validity of the concession.

Portugal.[27]—Mispickel ore mined near Oporto, Portugal, and said to average from 35 to 40 per cent of arsenic was offered at the rate of 150 tons a month to American consumers in 1923. The ore can be shipped by way of Douro River.

Spain.[28]—Arsenic mines in the Provinces of Gerona, Pontevedra, and Coruña, owned by Eduardo Gasset, of Puebla de Caraminal Coruña, were worked from 1908 to 1912 but then closed, as prices fell to an unprofitable level. White arsenic was produced during these years at Badalona, near Barcelona. The owner of these mines states that he could furnish annually 2,000 tons of 35 per cent arsenic ore from the Gerona mines and 4,000 to 6,000 tons annually of ore containing 25 per cent of arsenic from the mines in Pontevedra and Coruña.

The American consul at Huelva reports that the chief producers of pyrites in the Province of Huelva have stated that the amount of arsenic in their ores is too small to permit it to be successfully extracted as a by-product. The Rio Tinto company especially made a careful study of this question before arriving at that conclusion.

The American consul at Santander states that there were formerly two small mercury distilling plants at Mieres, Oviedo, which produced small quantities of arsenic as a by-product. The total production never exceeded 40 to 60 tons, and both plants have been closed since 1920.

In the Province of Lugo, Galicia, according to the American consul at Barcelona, a single company having 47 men produced 1,000 tons of arsenical pyrite in 1920.

South Africa.—Although there are many occurrences of arsenic ore throughout the mineralized portion of Transvaal, principally in the Barberton district, it has not been mined. In Rhodesia and eastern Transvaal the gold ores carry appreciable quantities of arsenic as arsenopyrite. In the Waterberg district tin ore with which arsenical minerals are found is too low in gold or tin to be of commercial value but sufficiently rich in arsenic to be made to pay if the demand for arsenic continues. According to the American

[27] Hollis, W. S. (American consul general, Lisbon), Opportunity for the purchase of crude arsenic, report, July 24, 1924 (U. S. Geol. Survey cons. file, No. 6021).

[28] Henry, F. A. (American consul, Barcelona), Production of arsenic ores and arsenious acid in Spain, report, Oct. 4, 1923 (U. S. Geol. Survey cons. file, No. 6114).

trade commissioner [29] the Standard Arsenic Co. (Ltd.), Salisbury, Rhodesia, offers to supply the American market with white arsenic at the rate of 50 to 100 tons a month. This company was making monthly 30 tons of white arsenic 99 per cent pure and had shipped 110 tons to brokers in New York City. The property is known as the Champion mine and is at Grand Reef siding, in the Umtali district. It is credited with a total output of 227 tons of white arsenic in 1922. Another mine, also named the Champion, in the Bulawayo district, owned by R. Aserman, produced 270 tons of arsenic.

Supplies of arsenical pyrite amounting to 20,000 tons containing from 33 to 46 per cent of arsenic were offered through the American consul [30] by S. Ginsberg, of Johannesburg. The ore occurs on a farm in Transvaal. An arsenic furnace was built at Breyton, Transvaal, in 1923 which roasts 4 tons of arsenical concentrate a day. The owner of the furnace, F. Porson Neve, of Lydenburg, believes that a custom plant would be profitable.

Two brands of cattle dip are manufactured from the arsenic produced from the ores mined in the Umtali and Gwanda districts.

China.—Tin ore carrying arsenical pyrite is obtained from Chengchow, Chungking, and Kweiyung, in the Province of Hunan, the one important source of arsenic in China, according to a report [31] issued from the office of the American consul general at Shanghai. Small shipments of white arsenic are also made from Chungking, Canton, and Kowloon. Parts of the report read as follows:

> The Geological Survey of China shows that in 1916 China's output of arsenic ores was 80,000 tons, valued at Mex. $2,400,000 (gold $1,076,240). This was 1.2 per cent of the world's production.
>
> Arsenic occurs in China in two forms—white arsenic (As_2O_3) and red, * * * Arsenic is also produced in China as a by-product of the smelting of cobalt, tin, antimony, and copper. The arsenical soot obtained by treating the crude ore is refined by placing it in an iron basin covered by a similar basin inverted, on which, after prolonged heat, the arsenious acid (white arsenic) is deposited as "glass." Most of the arsenic exported from Hunan Province is obtained in this way from tin ore carrying arsenical pyrites. The "red arsenic" of Chinese commerce is a natural product. The chief use of arsenic in China is as an insecticide, especially for the silkworms in Shantung. North China now consumes about 70 per cent of the arsenic produced in China. It is used as a dressing for farming lands, to preserve skins and furs, in the manufacture of pigments and aniline dyes, and in medicine.

British India.—In Chitral, British India, near the village of Partsan, a new discovery of arsenic sulphide was reported [32] in 1922. The mineral realgar is disseminated in calcareous shale over a width ranging from a few inches to several feet. The rocks in which the realgar occurs are of Cretaceous age and have been lowered by two large strike faults.

Turkey in Asia.[33]—Arsenic in Turkey is found in the Province of Smyrna and at Zara, in the Province of Sivas. The chief source in 1923 was the Balia lead mines, back of the Dardanelles, which have a maximum output of 262 tons a year. The mine is operated by

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[29] Stevenson, P. J. (American trade commissioner, Johannesburg), letter No. 655, May 23, 1923 (Bur. Foreign and Domestic Commerce file, No. 10170).

[30] Donald, G. K. (American consul, Johannesburg), report, July 25, 1923 (U. S. Geol. Survey cons. file, No. 6091).

[31] Emens, G. K. (clerk to American consul), report, Oct. 24, 1923 (U. S. Geol. Survey cons. file, No. 6315).

[32] Pascoe, E. H., India Geol. Survey Rec., vol. 45, pt. 1, pp. 13–14, Calcutta, 1923.

[33] Ravndal, G. B. (American consul general, Constantinople), report, Sept. 12, 1923 (U. S. Geol. Survey cons. file, No. 6199).

the Société anonyme de Balia Karaidin (French), whose output is principally lead and zinc, exported from the little port of Ak-Tchai, on the Gulf of Edremid (Aegean Sea), to Belgium and Germany. The output for 1921–1922 amounted to 200 tons of arsenic ore, which was exported to Belgium.

New South Wales.[34]—In New South Wales the output of white arsenic in 1922 was 291 long tons, valued at £14,818. The ore from which the arsenic was recovered came from the Bellingen, Emmaville, Moruya, Tumbarumba, and Tumut districts of New South Wales. Arsenical pyrite was mined from all properties operated for arsenic in these districts. The Valla gold mines, at Urunga, in the Bellingen district, produced 108 tons, yielding 6½ tons of concentrate. The Ottery mine, at Tent Hill, in the Emmaville district, operated by W. Cooper & Nephews (Ltd.), produced 2,823 tons of arsenical ore, which yielded 268 tons of white arsenic. Three roasting kilns were added to the arsenic plant, making a total of eight in operation during 1922. From the Webb's Consols mine, in the Emmaville district, 200 tons of arsenical pyrite, averaging 11 per cent of arsenic, was produced. In the Moruya district, near Peel, attempts were made to treat the ore of the Mount Conqueror mine during 1909 by the oxy-hydro process, and a similar process was tried with ore from the Moruya gold and silver mine, resulting in the production of 2 tons of white arsenic. During 1922 about 9 tons of arsenical ore was sold from these mines. In the Tumbarumba district 200 tons of 28 to 31 per cent arsenic ore from the Lankey's Creek mine, at Mount Gifford, was shipped for treatment to Bendigo, Victoria.

In the Tumut district the Edwards Chemical Co. at Brungle, mined 82 tons of arsenic ore, which was treated at Ballarat. Arsenical pyrite in this district is associated with iron and copper pyrite. The ore occurs as small disconnected lenses in porphyry. Other known occurrences of arsenic in New South Wales have been prospected, but only the districts mentioned proved important in 1922.

Queensland.—Native arsenic has been found in the Chillagoe and Herberton districts, on the Charters Towers gold field, at Kilkivan and Gympie, and mispickel in association with other minerals in a great number of other places throughout Queensland.[35] The State arsenic mine at Jibbinbar, near Stanthorpe,[36] was producing in 1923 more than 50 long tons of white arsenic monthly, which was more than enough to supply the local demand for the destruction of the prickly pear, for cattle and sheep dip, and for general manufacturing purposes. The surplus was exported to America. The white arsenic output of the State mine and two other mines[37] amounted to 610 long tons in 1923, an increase of 210 tons over the output of 1922.

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[34] Moseley, P. H. (American consul, Sydney), report, July 28, 1923 (U. S. Geol. Survey cons. file, No. 6128).
[35] Eng. and Min. Jour.-Press, June 30, 1923, p. 1170.
[36] Queensland Govt. Min. Jour., June 15, 1923.
[37] Idem, April 15, 1924.

COPPER

By Helena M. Meyer

INTRODUCTION

The production of metallic copper usually requires three distinct operations—mining, smelting, and refining. Different processes are used in each of the three operations, but ordinarily the preparation of the ore for smelting is the most varied and complicated. There is no considerable American source of copper except the Lake Superior native copper ores in which these three operations are not necessary. It is therefore possible to determine approximately the copper production of the United States by three separate sets of statistics, which may be obtained respectively from the mines, the smelters, and the refineries. These three sets of figures will never agree exactly, but each set has for certain purposes a particular advantage over the others, and the three together show the dominant features of the copper industry.

The mine figures make it possible to determine best the geographic distribution of production and are also the only source of accurate data as to the character and quantity of the ore, its content of copper and precious metals, and the degree to which it is concentrated before smelting. They show the estimated recoverable copper content but of course not the quantity of copper that will be recovered by the smelters. The smelter statistics show with fair accuracy the geographic distribution of the production and give the exact quantity of copper recovered from the ores, including considerable copper recovered from sulphur, lead, zinc, and siliceous ores that carry so little copper that the mines are not paid for it and do not report it. The refinery statistics show accurately the quantity of copper made available for consumption and the precious metals obtained in refining, but they do not show the distribution of the production among the States of origin and they are even uncertain in their separation of the material refined into foreign and domestic. One difference between the mine and the smelter figures may be produced by a difference in the quantity of ore, matte, or other material held in stock at the smelter at the beginning and the end of the year, and one difference between the smelter and the refinery statistics may be produced by a difference in the quantity of unrefined copper in stock at the refinery at the beginning and the end of the year.

The principal cause of differences between the three sets of figures, however, is the difference in time in the successive stages of production of refined copper. The interval between the time the ore is mined and the time the refined copper is available for commercial use is ordinarily two to three months. It is therefore clear that refinery statistics for the calendar year 1923, for example, cover ore that was mined probably between October, 1922, and October, 1923. Consequently a decided slump or a decided stimulation at the beginning or the end

of any year would cause a marked difference in the three sets of figures; but during periods of normal operation there should be no great difference between them.

As the smelter figures permit reasonably accurate determination of the distribution of copper as to source by States and give the actual output of copper, the smelter output is adopted in this report as the production of the country. It is made up of the production of blister copper and of furnace-refined or ingot copper of the Lake district.

SUMMARY OF DOMESTIC AND WORLD STATISTICS

Summary of statistics of the copper industry in the United States, 1918–1923

	1918	1919	1920
Production of copper:			
Smelter output—pounds	1,908,533,595	1,286,419,329	1,209,061,040
Mine production—do	1,910,022,841	1,212,334,041	1,224,550,151
Refinery production of new copper—			
Electrolytic—do	1,560,327,422	1,233,994,324	1,010,240,867
Lake—do	231,096,158	177,594,135	153,483,952
Casting and pig—do	91,450,611	21,897,336	18,698,421
Total domestic—do	1,882,874,191	1,433,485,795	1,182,423,240
Total domestic and foreign—do	2,394,297,521	1,770,168,041	1,526,165,346
Total new and old copper—do	3,100,000,000	2,345,000,000	2,151,000,000
Ore produced:			
Copper ore—short tons	62,289,069	36,121,622	36,765,370
Average yield of copper—per cent	1.51	1.65	1.63
Average cost per pound of copper produced—cents	14.49	15.25	14.94
Other ore yielding copper—short tons	15,693	17,632	26,890
Average price per pound—cents	24.7	18.6	18.4
Imports (unmanufactured)—pounds	575,805,115	429,387,594	485,670,691
Exports of metallic copper [a]—do	744,243,481	515,595,019	623,158,489
Withdrawn from total supply on domestic account:			
Total new copper—pounds	1,661,669,576	914,471,572	1,053,838,558
Total new and old copper—do	2,367,000,000	1,489,000,000	1,679,000,000
Stocks of refined copper [b]—do	180,000,000	631,000,000	659,000,000
Stocks of blister and materials in solution [b]—do	562,000,000	273,000,000	465,000,000
World's production—do	3,148,499,000	2,191,394,000	2,112,028,000
Value of smelter production from domestic ores	$471,408,000	$239,274,000	$222,467,000

	1921	1922	1923
Production of copper:			
Smelter output—pounds	505,586,098	950,285,947	1,434,999,962
Mine production—do	466,190,853	964,583,894	1,477,739,709
Refinery production of new copper—			
Electrolytic—do	506,532,984	766,944,836	1,302,454,492
Lake—do	100,918,001	122,545,126	137,691,306
Casting and pig—do	1,963,271	15,180,723	24,019,197
Total domestic—do	609,414,256	904,670,685	1,464,164,995
Total domestic and foreign—do	950,777,815	1,255,515,959	1,979,835,616
Total new and old copper—do	1,385,000,000	1,927,000,000	2,802,000,000
Ore produced:			
Copper ore—short tons	13,396,382	26,893,247	45,519,317
Average yield of copper—per cent	1.70	1.74	1.58
Average cost per pound of copper produced—cents	[c]	[c]	[c]
Other ore yielding copper—short tons	14,248	52,370	162,181
Average price per pound—cents	12.9	13.5	14.7
Imports (unmanufactured)—pounds	350,472,611	541,013,220	676,473,338
Exports of metallic copper [a]—do	628,415,714	742,755,957	828,854,827
Withdrawn from total supply on domestic account:			
Total new copper—do	610,988,744	896,633,833	1,300,473,331
Total new and old copper—do	1,046,000,000	1,568,000,000	2,122,000,000
Stocks of refined copper [b]—do	459,000,000	216,000,000	264,000,000
Stocks of blister and materials in solution [b]—do	283,000,000	361,000,000	432,000,000
World's production—do	1,227,974,000	1,862,906,000	[c]
Value of smelter production from domestic ores	$65,221,000	$128,289,000	$210,945,000

[a] Total exports of copper, exclusive of ore, concentrates, and composition metal, and in 1923 of unrefined copper, figures for which are not separable from those for ore and concentrates.
[b] At the end of the year.
[c] Figures not yet available.

Copper produced in the United States from domestic ores, 1918–1923

[Smelter output, in pounds fine]

State	1918	1919	1920	1921	1922	1923
Alaska	67,081,648	56,534,992	66,093,924	76,808,114	59,900,579	68,648,368
Arizona	769,521,729	536,515,368	552,988,731	155,165,656	428,200,634	615,493,561
California	44,150,761	23,548,698	11,822,028	15,906,883	20,440,430	27,042,835
Colorado	7,591,570	4,892,558	4,282,616	6,592,598	3,635,916	4,343,418
Georgia	397,078	8,306	3,663		8,147	
Idaho	5,836,795	3,966,655	1,922,116	1,971,623	3,504,944	3,664,079
Maine	501,169	376,186		3		
Michigan	231,096,158	177,594,135	153,483,952	100,918,001	122,545,126	137,691,306
Missouri	232,073	588,570	533,368	137,591	1,070,259	217,449
Montana	326,426,761	176,289,873	177,743,747	49,471,206	165,341,414	224,353,764
Nevada	106,266,603	64,683,734	55,580,322	15,129,116	20,398,611	63,495,928
New Mexico	96,559,580	60,377,320	52,159,751	18,076,909	29,127,329	57,521,171
North Carolina	79,200	3,334				61,913
Oregon	2,630,499	2,808,017	2,529,311	274,934	925,954	1,182,437
Pennsylvania	34,500		618,361		888,721	1,121,573
South Carolina		2,297				
South Dakota		8,631	2,190			47
Tennessee	15,053,568	15,629,454	16,727,803	15,084,294	14,226,232	18,721,932
Texas	13,851	2,153	14,217	587	3,889	4,216
Utah	230,964,908	143,836,304	110,357,748	45,831,959	79,665,563	210,118,291
Vermont	896,630	582,561				
Virginia	1,248					
Washington	2,330,568	2,552,134	2,125,586	598,658	369,133	839,254
Wyoming	866,698	150,051	24,256	9,830		87,686
Undistributed		15,467,998	47,350	3,608,136	33,066	390,734
	1,908,533,595	1,286,419,329	1,209,061,040	505,586,098	950,285,947	1,434,999,962

The following figures showing world production have been taken from statistics compiled by W. I. Whiteside, of the Geological Survey:

World's production of copper (smelter output), 1919–1923, in metric tons [a]

[Where no footnotes are given, figures are taken from official publications. For countries from which ore or matte was exported for smelting official figures have been converted to figures showing the quantity of copper recoverable by the smelters.]

Country	1919	1920	1921	1922	1923
Canada	34,044	37,014	21,600	19,450	[b] 39,409
Cuba	[c] 7,500	[c] 8,400	[c] 8,200	[c] 11,800	[c] 11,000
Mexico	56,172	49,192	15,228	26,978	[d] 53,372
United States	583,516	548,426	229,332	431,047	650,912
North America	681,232	643,032	274,360	489,275	754,693
Bolivia	9,524	9,982	10,592	10,531	10,049
Chile	79,589	98,952	59,239	129,575	[b] 175,460
Peru	39,230	32,982	33,284	36,408	44,166
Venezuela	[f] 188	[c] 400	[c] 800	[c] 1,700	[e]
South America	128,522	142,316	103,915	178,214	[e]
Austria	648	1,645	4,277	4,593	4,833
England	146	129	73	106	[e]
Finland	[c] 730	[c] 460	[c] 200	[c] 750	[c] 507
Germany	15,861	14,976	15,514	[g] 17,000	[g] 17,000
Italy	1,374	635	356	319	494
Norway	437	556	1,348	80	[e]
Portugal	[c] 650	[g] 1,000	[c] 1,600	[h]	[e]
Rumania	[i] 14	[i] 165	[i] 108	[i] 111	[e]
Russia	[h]	[i] 3,751	[i] 4,668	[h]	[e]

[a] In addition to the countries shown, Chosen is reported to have produced 2,288 metric tons of crude copper in 1919 and 5,368 metric tons in 1920. Just what material this "crude copper" includes can not be determined.
[b] Preliminary.
[c] Estimated by the U. S. Geological Survey.
[d] Consulate general of Mexico, Eng. and Min. Jour.-Press of Apr. 19, 1924.
[e] Figures not yet available.
[f] Figures from Imperial Mineral Resources Bureau.
[g] According to the American Bureau of Metal Statistics.
[h] Figures not yet available, but an estimate is included in the total.
[i] For the year ending Mar. 31 following that stated in the heading of the column.
[j] Min. Jour. (London), Apr. 8, 1922.

World's production of copper (smelter output), 1919–1923, in metric tons—Contd

Country	1919	1920	1921	1922	1923
Spain	23,419	22,458	36,345	25,139	45,266
Sweden	3,558	1,289	1,149	----------	(*)
Yugoslavia	(h)	2,436	4,144	5,354	6,788
Europe	k 52,837	49,500	69,782	k 58,450	(*)
China	l 554	l 191	l 958	l 313	(*)
Japan	78,443	67,792	54,092	54,126	59,346
Taiwan	884	692	1,197	1,096	(*)
Asia	79,881	68,675	56,247	55,535	(*)
Algeria	c 60	c 430	c 300	c 430	c 560
Belgian Congo	23,019	18,962	30,464	43,362	m 56,479
Rhodesia:					
Northern	185	132	200	181	132
Southern	2,732	2,820	2,794	3,074	2,697
Southwest African Protectorate	c 2,400	c 4,370	c 7,400	c 3,900	(*)
Union of South Africa	3,577	1,075	92	665	7,980
Africa	31,973	27,789	41,250	51,612	(*)
Australia	19,491	27,022	11,147	12,040	(*)
Grand total	k 994,000	958,000	557,000	k 845,000	(*)

c Estimated by the U. S. Geological Survey.
* Figures not yet available
h Figures not yet available, but an estimate is included in the total.
k Includes estimate for countries for which information is not yet available.
l Exports of ingots and slabs.
m L'Écho des mines.

GENERAL CONDITIONS

The higher prices prevailing during the first part of 1923 caused many companies which had been operating at a curtailed rate of production to increase this rate, with the result that smelter production was 51 per cent greater than in 1922. Both smelter and refinery production in 1923 were the highest ever attained except during the very abnormal World War years 1916, 1917, and 1918, and although domestic withdrawals were also the highest ever attained except during those years, they were not high enough to keep stocks from increasing and prices from dropping to less than 13 cents a pound during the later part of the year. The domestic consumption has been remarkably great, and had European demand been up to expectations it is very unlikely that the copper industry would be in its present unsatisfactory condition. Although exports of metallic copper increased over those in 1922, they were below those reported for 1913 and 1914, and imports of unmanufactured copper, which increased more than exports, were the highest ever recorded and were over 50 and 100 per cent, respectively, greater than those reported for 1913 and 1914. The gradual lessening of the surplus of exports over imports has caused some of the copper producers to feel that a tariff on copper would solve some of the perplexing problems with which producers have had to deal during the period of low prices. It is largely this condition that has caused the agitation among the high-cost producers for a tariff on copper, resulting in the introduction in May, 1924, of a bill in Congress by Representative James, of Michigan, providing a duty of 6 cents a pound on copper imported.

Stocks of refined copper were increased from 216,000,000 pounds at the end of 1922 to 264,000,000 pounds at the end of 1923 but were still very much smaller than the stocks of 1919, 1920, and 1921. Although the refined stocks at the end of 1923 were over twice as large as those held prior to the war period, it should be borne in mind

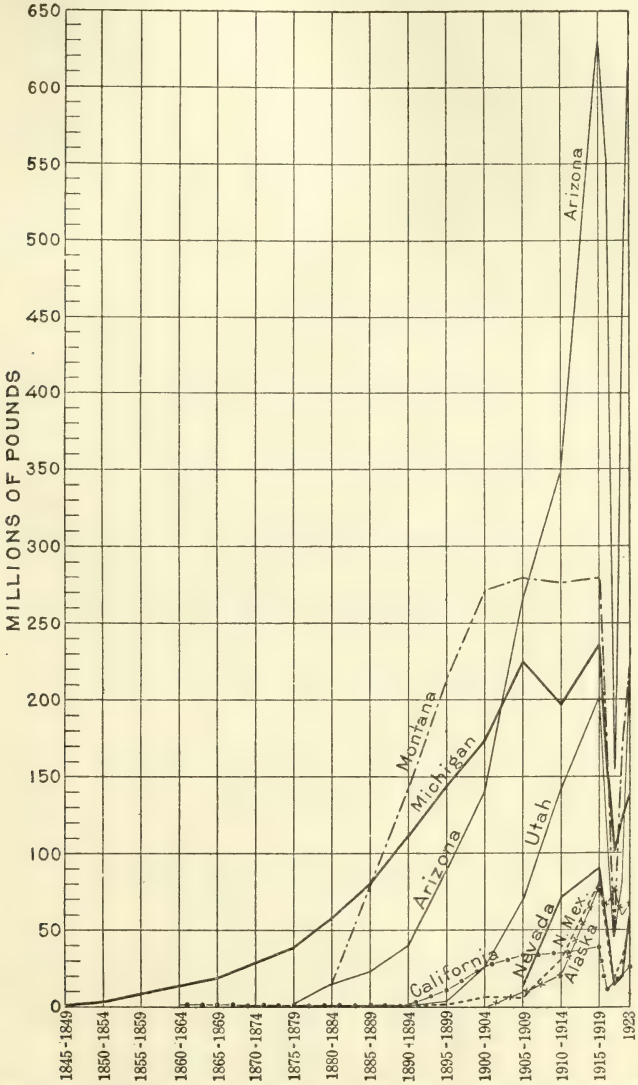

FIGURE 9.—Production of copper in the principal producing States, by averages of five-year periods, 1845–1923

that domestic withdrawals have greatly increased since pre-war days and were about 60 per cent higher than those for 1913. Consequently larger stocks were not as significant or as burdensome as they would have been had requirements during the year been smaller.

One element in the world market which has disturbed the producers in the United States is the largely increased production from

the mines of South America and South Africa. Production in Chile has increased from 129,575 metric tons in 1922 to 175,460 tons in 1923, and in Belgian Congo from 43,362 tons in 1922 to 56,479 tons in 1923. These increases have led to stronger competition with the producers of the United States in the important European markets, which, owing to unfavorable conditions there, have not been able to purchase the quantity of copper they needed. Considerable improvement is looked for in European financial conditions, especially in Germany, and any gain in ability to purchase will mean an improvement in these foreign markets for copper.

In the meantime, except for the proposed tariff, which is not sponsored by all copper producers, the hope of the copper companies seems to lie in restriction of production and increase in home consumption. Home consumption during the year was admittedly all that could be expected. Restriction of production is costly, and the

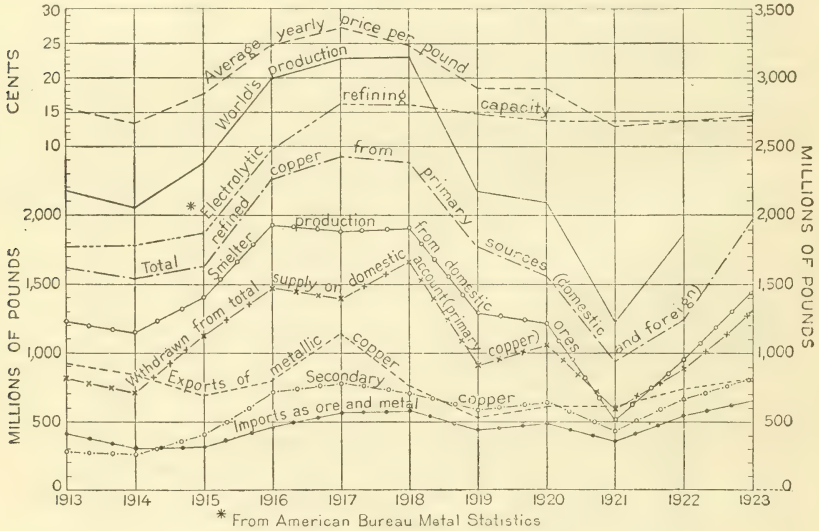

FIGURE 10.—Principal features of the copper industry, 1913–1923

producers who have been producing copper at a loss during the post-war years can not go on indefinitely depleting reserves of ore and capital.

Many of the copper companies have been able to cut costs of production considerably by increased efficiency of operation and labor, by consolidation of mining companies, and by closer cooperation between producers and manufacturers and have realized a good profit on 13-cent copper.

During the year the Copper and Brass Research Association has continued its successful research program for finding new uses for copper and brass and its general efforts to stimulate the consumption of copper.

The Utah Copper Co. was absorbed by the Kennecott Copper Corporation in 1923, and the Calumet & Hecla, Ahmeek, Allouez, Centennial, and Osceola companies were formed into the Calumet & Hecla Consolidated Copper Co. Further consolidations have taken place in 1924, and some others are under consideration.

PRODUCTION

SMELTER PRODUCTION

The smelter production of copper from domestic ores increased from 950,285,947 pounds in 1922 to 1,434,999,962 pounds in 1923, a gain of about 51 per cent. The production in 1923 was the largest ever recorded except during the years of abnormal demand, 1916, 1917, and 1918, and represents an increase of approximately 184 per cent over that in 1921. The production in 1921 was the smallest since 1897; that in 1922 represented an increase of 88 per cent but was except for 1921 the smallest since 1908.

It is of interest to note the relation which the smelter production from domestic ores in the United States bears to the world's production. In 1913 it represented 56 per cent of the total world's production; in 1918, 61 per cent; in 1920, 57 per cent; in 1921, 41 per cent; and in 1922, 51 per cent. Figures of world production for 1923 are not yet complete, but the percentage will probably be about the same as in 1922.

The value of the smelter output from domestic ores increased approximately 64 per cent in 1923, from $128,289,000 to $210,945,000.

The figures of smelter production in 1923 are based on returns made confidentially to the United States Geological Survey by all known smelting companies handling copper-bearing materials from the United States. To all companies and officials who have aided in furnishing this information and have given valuable time to answering inquiries concerning distribution of the output sincere thanks are extended. The following list gives the names of the owning or operating companies, the location, and the final copper product of smelting and refining plants treating material from the United States during 1923. It does not include lead and zinc plants that recovered copper as a by-product from mixed ores. Lists of lead and zinc smelters can be found in the reports on those metals.

Copper reduction plants that treated materials from the United States in 1923 [a]

Location	Company	Final copper product
Arizona:		
Ajo	New Cornelia Copper Co	Electrolytic.
Clarkdale	United Verde Copper Co	Blister.
Do	United Verde Extension Mining Co	Do.
Douglas	Calumet & Arizona Mining Co	Do.
Do	Phelps Dodge Corporation	Do.
Globe	Old Dominion Co	Do.
Hayden	American Smelting & Refining Co	Do.
Humboldt	Southwest Metals Co	Do.
Miami	International Smelting Co	Do.
Clifton	Phelps Dodge Corporation	Do.
California:		
Kennett	United States Smelting, Refining & Mining Co	Do.
Martinez	Mountain Copper Co (Ltd.)	Do.
Maryland: Baltimore	Baltimore Copper Smelting & Rolling Co	Electrolytic.
Michigan:		
Hancock	Quincy Mining Co	Anodes and lake.
Houghton	Michigan Smelting Co	Do.
Hubbell	Calumet & Hecla Mining Co	Do.
Montana:		
Anaconda	Anaconda Copper Mining Co	Blister.
Butte	East Butte Copper Mining Co	Do.
Great Falls	Anaconda Copper Mining Co	Blister and electrolytic.

[a] This list does not include a smelter in Pennsylvania, which made blister from material solely of foreign origin.

Copper reduction plants that treated materials from the United States in 1923—Con.

Location	Company	Final copper product
Nevada: McGill	Nevada Consolidated Copper Co	Blister.
New Jersey:		
Chrome	United States Metals Refining Co	Blister and electrolytic.
Maurer	American Smelting & Refining Co	Blister, electrolytic, and casting.
Newark	Balbach Smelting & Refining Co	Casting.
Perth Amboy	Raritan Copper Works	Electrolytic.
New York: Laurel Hill	Nichols Copper Co	Blister and electrolytic.
Tennessee:		
Copperhill	Tennessee Copper Co	Blister.
Isabella	Ducktown Sulphur, Copper & Iron Co. (Ltd.)	Do.
Texas: El Paso	American Smelting & Refining Co	Do.
Utah:		
Garfield	Garfield Smelting Co	Do.
International	International Smelting Co	Do.
Virginia: West Norfolk	Norfolk Smelting Co	Do.
Washington: Tacoma	American Smelting & Refining Co	Blister and electrolytic

During the year 32 copper smelting and refining plants treated material from the United States; all of these were domestic plants.

The figures of production represent the actual smelter recovery. For Michigan it is the sum of furnace-refined copper and copper cast into anodes for electrolytic refining. As to blister copper, the figures represent the fine copper content. Some casting and electrolytic copper is produced direct from ore or matte, and this is included in the smelter production. Metallic and cement copper recovered by leaching is also included in smelter production.

MINE PRODUCTION

The figures of mine production are based on reports furnished to the United States Geological Survey by all mines producing copper.

The mines and smelters of several of the large copper producers are under the same management, and their production is reported on the same basis. The figures furnished by mines that ship to custom smelters or have only matting furnaces and ship their matte for conversion are likely to show considerable discrepancy from the smelter returns, as the mines may report a considerable quantity that has not reached the stage of blister copper by the end of the year and is consequently not included in the smelter production, or material that was reported by the mines in one year may be treated by the smelters in the following year. This discrepancy is more pronounced if a marked curtailment of production occurs at the beginning or the end of the year, so that there is not the balance of overlap that occurs if the industry is in normal condition throughout the year. Considerable copper is recovered by the smelters from ores that are treated primarily for other metals, the copper content being so low that it is not paid for and consequently is not always reported by the mines.

The difference between the smelter and the refinery production is accounted for entirely by an increase in the stocks of blister copper plus the copper content of bluestone produced and the loss in refining.

Copper produced from domestic ores as reported by mines, smelters, and refineries, 1918–1923, in pounds

Year	Mine	Smelter	Refinery
1918	1,910,022,841	1,908,533,595	1,882,874,191
1919	1,212,334,041	1,286,419,329	1,433,485,795
1920	1,224,550,151	1,209,061,040	1,182,423,240
1921	466,190,853	505,586,098	609,414,256
1922	964,583,894	950,285,947	904,670,685
1923	1,477,739,709	1,434,999,962	1,464,164,995

PRODUCTION BY STATES

Eighteen States and one Territory contributed to the smelter production of copper in 1923. The subjoined table shows the mine and the smelter output of individual States for 1922 and 1923.

Copper produced in the United States in 1922 and 1923, according to smelter and mine returns, by States, in pounds

State	1922		1923		
			Smelter returns		
	Smelter returns	Mine returns	Percentage of total	Quantity	Mine returns
Alaska	59,900,579	77,967,819	4.78	68,648,368	85,920,645
Arizona	428,200,634	400,043,128	42.89	615,493,561	618,928,602
California	20,440,430	22,539,485	1.88	27,042,835	28,317,759
Colorado	3,635,916	3,373,454	.30	4,343,418	4,248,109
Georgia	8,147	6,000			
Idaho	3,504,944	3,282,842	.26	3,664,079	3,979,631
Michigan	122,545,126	121,712,365	9.60	137,691,306	138,304,080
Missouri	1,070,259	797,400	.02	217,449	202,556
Montana	165,341,414	165,754,442	15.64	224,353,764	224,125,264
Nevada	20,398,611	23,133,091	4.42	63,495,928	67,204,282
New Mexico	29,127,329	31,937,207	4.01	57,521,171	61,356,802
North Carolina				61,913	61,983
Oregon	925,954	1,046,525	.08	1,182,437	1,283,476
Pennsylvania	888,721	1,229,926	.08	1,121,573	1,703,480
South Dakota				47	
Tennessee	14,226,232	14,240,571	1.30	18,721,932	18,721,932
Texas	3,889	4,290		4,216	4,257
Utah	79,665,563	97,193,850	14.64	210,118,291	222,393,572
Washington	369,133	317,203	.06	839,254	871,999
Wyoming		4,296	.01	87,686	111,280
Undistributed	33,066		.03	390,734	
	950,285,947	964,583,894	100	1,434,999,962	1,477,739,709

According to smelter returns, the four leading States in 1923—Arizona, Montana, Utah, and Michigan—produced 83 per cent of the total output, as compared with 84 per cent from the four leading States in 1922; and the eight leading States, including the four named and Alaska, Nevada, New Mexico, and California, produced 98 per cent of the total output in 1923, compared with 97 per cent in 1922.

Copper produced in the United States, 1845–1923, by States

[Smelter output]

State	Pounds	Percentage	Rank
Alaska	803, 806, 531	2. 47	7
Arizona	9, 544, 620, 128	29. 37	1
California	843, 668, 318	2. 60	6
Colorado	298, 584, 520	. 92	10
Idaho	121, 619, 638	. 37	11
Michigan	7, 221, 614, 536	22. 23	3
Montana	8, 451, 089, 649	26. 01	2
Nevada	1, 041, 402, 973	3. 21	5
New Mexico	802, 851, 895	2. 47	8
Oregon	17, 658, 285	. 05	14
Tennessee	[a] 431, 501, 000	1. 33	9
Utah	2, 698, 346, 815	8. 30	4
Washington	18, 903, 457	. 06	13
Wyoming	31, 672, 806	. 10	12
Other States and unapportioned	165, 600, 928	. 51	----------
	32, 492, 941, 479	100. 00	----------

[a] Approximate production.

The three States that have made the largest production are Arizona, Montana, and Michigan. These three States together have produced about 78 per cent of the output of the United States.

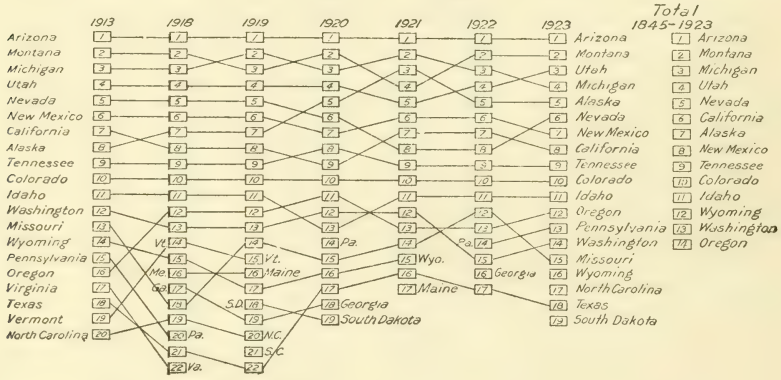

FIGURE 11.—Rank of States producing copper, 1913, 1918–1923, and 1845–1923

QUANTITY AND ESTIMATED RECOVERABLE CONTENT OF COPPER-BEARING ORES

For many years the general report on copper in Mineral Resources has contained a section on mine production of copper, including tables showing copper ore produced, copper ore concentrated, smelted, leached, etc. In order to include this section, it has been necessary to hold up the general report until all mine figures were available, and consequently the following plan, which makes it possible to publish this report sooner, has been decided upon: The copper chapter for 1923 will be published with figures of mine production for 1922, but as soon as complete 1923 mine figures are available they will be published in a press notice. These figures will be used in the chapter for 1924 also.

The following tables show the quantity and the estimated recoverable content in copper of the ore produced by the mines of the United

States in 1920–1922. The figures are taken from the mine reports in Mineral Resources. The close agreement between the output as reported by the smelters and the recoverable quantity as reported by the mines indicates that the estimated recoverable tenor is very close to the actual recovery. The classification of some of the complex western ores is difficult and more or less arbitrary. Under copper ores are classed not only those which contain 2.5 per cent or more of copper but those which contain less than this percentage if their principal value is in copper. Under copper-lead and copper-zinc ores are classed complex ores in which copper is a valuable constituent. Considerable copper was reported by the mines from ores mined primarily for other metals, including siliceous gold and silver ores, lead ores, zinc ores, pyritic sulphur ores, and ores concentrated for their content of other metals. No attempt has been made to compile tables showing the quantity and recoverable content of this group of copper-bearing ores, but together with old slags and other materials they yielded a total of 27,380,657 pounds of copper in 1922.

Copper produced in the United States in 1920–1922 from ores in which copper constitutes the principal value

State	1920		1921		1922	
	Copper ore (short tons)	Copper in ore (pounds)	Copper ore (short tons)	Copper in ore (pounds)	Copper ore (short tons)	Copper in ore (pounds)
Alaska	765,018	70,398,442	476,967	56,974,837	581,384	77,967,469
Arizona	14,516,580	557,364,143	5,181,177	184,812,780	10,431,729	[a] 399,014,848
California	346,201	12,489,269	306,134	11,599,540	447,200	21,845,111
Colorado	3,835	383,427	22,195	1,164,248	863	105,864
Idaho	19,259	1,738,541	10,322	1,105,511	32,590	2,572,335
Michigan	5,938,967	154,695,073	3,610,648	86,370,028	4,952,264	121,712,365
Montana	4,002,491	172,581,159	928,461	46,888,812	3,250,213	[a] 152,823,229
Nevada	2,616,237	49,858,120	401,153	10,318,851	629,408	[a] 22,452,852
New Mexico	2,090,711	52,462,145	533,231	13,637,034	1,477,166	31,669,547
Oregon	34,804	2,353,276	2,398	174,300	17,117	1,012,189
Tennessee	589,853	16,727,803	564,457	15,084,294	557,750	14,240,571
Texas	227	14,435			73	4,290
Utah	5,778,373	108,645,375	1,357,857	27,321,481	[b] 4,509,380	[a b] 90,523,462
Washington	62,814	1,975,604	1,332	246,017	6,086	312,912
Wyoming			50	10,000	24	4,296
	36,765,370	1,201,686,812	13,396,382	455,707,733	26,893,247	936,261,340

[a] Exclusive of copper recovered as precipitates from mine waters, as follows: Arizona, 249,343 pounds; Montana, 10,037,514 pounds; Nevada, 187,190 pounds; Utah, 563,718 pounds.
[b] Exclusive of 4 tons of slag, containing 827 pounds of copper.

Copper ores concentrated and smelted, and copper produced from each class of ore in the United States in 1920–1922

State	Ore concentrated					
	1920		1921		1922	
	Short tons	Copper in concentrates (pounds)	Short tons	Copper in concentrates (pounds)	Short tons	Copper in concentrates (pounds)
Alaska	732, 549	50, 996, 706	448, 236	34, 585, 960	544, 212	48, 423, 640
Arizona	10, 185, 491	254, 663, 629	3, 632, 342	94, 634, 203	7, 617, 726	202, 095, 491
California	342, 393	11, 644, 411	306, 024	11, 580, 827	431, 601	19, 890, 598
Idaho	2, 912	105, 159	300	8, 686	15, 776	708, 291
Michigan	5, 938, 967	[a] 154, 695, 073	3, 610, 648	[a] 86, 370, 028	4, 952, 264	[a] 121, 712, 365
Montana	3, 883, 851	163, 928, 028	881, 051	40, 447, 426	3, 132, 253	142, 465, 556
Nevada	2, 594, 466	48, 048, 849	392, 645	8, 824, 837	518, 523	9, 745, 733
New Mexico	2, 069, 292	50, 560, 611	533, 165	13, 633, 402	1, 416, 869	28, 406, 314
Oregon	34, 804	2, 353, 276	2, 398	174, 300	15, 070	813, 869
Tennessee			102, 517	2, 801, 200	138, 440	2, 803, 994
Utah	5, 502, 395	101, 848, 546	1, 113, 218	23, 813, 053	4, 471, 711	88, 098, 018
Washington	61, 220	1, 743, 395			4, 525	78, 284
	31, 348, 340	840, 587, 683	11, 022, 544	316, 873, 922	23, 258, 970	665, 242, 153

State	Ore smelted					
	1920		1921		1922	
	Short tons	Copper produced (pounds)	Short tons	Copper produced (pounds)	Short tons	Copper produced (pounds)
Alaska	32, 469	19, 401, 736	28, 731	22, 388, 877	37, 172	29, 543, 829
Arizona	2, 362, 250	258, 913, 975	617, 786	69, 971, 143	1, 457, 773	169, 963, 032
California	3, 808	844, 858	110	18, 713	15, 599	1, 954, 513
Colorado	3, 835	383, 427	22, 195	1, 164, 248	863	105, 864
Idaho	16, 347	1, 633, 382	10, 022	1, 096, 825	16, 814	1, 864, 044
Montana	75, 730	6, 314, 734	47, 410	6, 441, 386	117, 960	10, 357, 673
Nevada	21, 421	1, 802, 771	8, 508	1, 494, 014	110, 885	12, 707, 119
New Mexico	21, 419	1, 901, 534	66	3, 632	60, 297	3, 263, 233
Oregon					2, 047	198, 320
Tennessee	589, 853	16, 727, 803	461, 940	12, 283, 094	419, 310	11, 436, 577
Texas	227	14, 435			73	4, 290
Utah	71, 556	4, 632, 793	37, 452	2, 766, 069	37, 669	2, 425, 444
Washington	1, 594	232, 209	1, 332	246, 017	1, 561	234, 628
Wyoming			50	10, 000	24	4, 296
	3, 200, 509	312, 803, 657	1, 235, 602	117, 884, 018	2, 278, 047	244, 062, 862

[a] Includes copper from sands.

Copper derived from ores classed as copper-bearing (copper, copper-lead, and copper-zinc ores), and total production of copper from all sources in the United States, 1920–1922

State	1920			1921			1922		
	Ore treated (short tons)	Copper recovered (pounds)	Copper from all sources, including old slags, smelter cleanings, and precipitates (pounds)	Ore treated (short tons)	Copper recovered (pounds)	Copper from all sources, including old slags, smelter cleanings, and precipitates (pounds)	Ore treated (short tons)	Copper recovered (pounds)	Copper from all sources, including old slags, smelter cleanings, and precipitates (pounds)
Alaska	765,018	70,398,442	70,435,363	476,967	56,974,837	57,011,597	581,384	77,967,469	77,967,819
Arizona [a]	14,521,688	557,537,803	558,256,302	5,181,318	184,823,028	185,034,194	10,432,164	399,040,128	400,043,128
California	346,201	12,489,269	12,626,272	306,134	11,599,540	11,743,404	447,247	21,849,249	22,539,485
Colorado [b]	4,288	414,292	4,043,734	23,015	1,242,696	4,153,442	1,490	166,163	3,373,454
Georgia	240	5,780	5,780				600	6,000	6,000
Idaho	24,274	1,808,332	2,538,396	19,444	1,231,228	1,688,195	58,733	2,864,430	3,282,842
Michigan	5,938,967	154,695,073	154,695,073	3,610,648	86,370,028	86,370,028	4,952,264	121,712,365	121,712,365
Missouri			1,512,539			137,591			797,400
Montana [c]	4,005,523	172,667,631	177,059,260	928,795	46,913,200	48,098,730	3,271,464	153,027,726	165,754,442
Nevada	2,622,506	50,232,865	50,559,763	402,842	10,346,763	10,961,491	629,510	22,464,135	23,133,091
New Mexico [d]	2,091,005	52,491,434	54,400,691	533,609	13,686,274	14,267,338	1,479,059	31,882,619	31,937,207
Oregon	34,804	2,353,276	2,355,276	2,398	174,300	174,300	17,117	1,012,189	1,046,525
Pennsylvania			405,092			313,302			1,229,926
Tennessee	589,853	16,727,803	16,727,803	564,457	15,084,294	15,084,294	557,750	14,240,571	14,240,571
Texas	227	14,435	14,435				73	4,290	4,290
Utah	5,784,762	109,052,772	116,931,238	1,359,621	27,431,494	30,891,403	4,510,652	90,648,695	97,193,850
Washington	62,904	1,981,061	1,983,134	1,332	246,017	251,544	6,086	312,912	317,203
Wyoming				50	10,000	10,000	24	4,296	4,296
	36,792,260	1,202,870,268	1,224,550,151	13,410,630	456,133,699	466,190,853	26,945,617	937,203,237	964,583,894

[a] A quantity of copper was recovered from old slags and ores not classed as copper ores.
[b] Most of the copper from Colorado is derived from ores classed as siliceous ores and lead ores.
[c] Considerable copper was recovered as precipitates from mine waters and from ores not classed as copper ores.
[d] A quantity of copper was derived from ores classed as lead ores and siliceous ores.

Copper ores produced in the United States, 1918–1922, and average yield in copper, gold, and silver

Year	Smelting ores		Concentrating ores		Total				
	Short tons	Yield in copper (per cent)	Short tons	Yield in copper (per cent)	Short tons	Yield in copper (per cent)	Yield per ton in gold (ounce)	Yield per ton in silver (ounce)	Value per ton in gold and silver
1918	6,223,674	4.51	53,937,796	1.18	62,289,069	1.51	0.0050	0.328	$0.50
1919	3,465,880	4.64	30,769,966	1.35	36,121,622	1.65	.0052	.356	.51
1920	3,200,509	4.89	31,348,340	1.34	36,765,370	1.63	.0047	.331	.46
1921	1,235,602	4.77	11,022,544	1.44	13,396,382	1.70	.0039	.357	.44
1922	2,278,047	5.36	23,258,970	1.43	26,893,247	1.74	.0049	.386	.49

REVIEW BY COMPANIES AND STATES

SCOPE OF DISCUSSION

In the following pages a brief statement of the conditions affecting production in the principal copper districts of the country is presented, and the tenor of the ore from each district is given, so far as it does not disclose the production of those individual companies whose figures of output have not already been published in their annual reports or elsewhere. More detailed information on the mining operations of the districts will be given in the reports on mine production.

Figures of metal output, ore reserves, metal content, and recovery in treatment of individual companies given in this report, unless otherwise stated, are quoted from the published official reports of the companies. The chapter on copper in Mineral Resources for 1915 contains a map showing the location of the copper-producing districts and the metallurgic plants and also a brief discussion of the geologic occurrence of the ores in the different districts.

The American Smelting & Refining Co., which has various kinds of mines and plants throughout the United States and in several foreign countries, reports that net income available for dividends, after deducting all charges, taxes, bond interest, depreciation, and depletion, increased from $5,918,142.94 in 1922 to $8,924,581.56 in 1923. Dividends at the rate of 5 per cent a year on the common stock were resumed during 1923, the first quarterly dividend being paid on August 1. The company is erecting a new copper smelter and arsenic plant at San Luis Potosi, Mexico. Production and operating statistics of the company for several years are shown in the following table:

Operations of the American Smelting & Refining Co., 1914, 1921, 1922, and 1923

	1914	1921	1922	1923
Production.				
Gold ounces	2,540,911	1,780,205	1,744,550	1,871,790
Silver do	77,604,483	75,354,443	84,793,931	94,424,778
Platinum and palladium do	1,664	863	1,165	1,615
Lead short tons	316,591	207,612	252,898	338,284
Copper pounds	529,686,000	348,888,000	433,548,000	834,340,000
Zinc do	15,748,000	14,628,614	35,040,000	59,813,434
Nickel do	356,187	120,080	314,586	452,388
Tin do		11,915,954	3,766,000	5,166,458
Sulphuric acid do	24,296,000	9,952,000	28,494,000	66,386,000
Arsenic do	6,184,000	5,155,522	11,203,052	14,838,789
Copper sulphate do	6,798,000	2,237,471	2,274,000	2,060,000
By-product metals do	1,678,228	3,232,488	12,700,577	13,392,509
Sulphur dioxide do		154,794	1,611	
Operating statistics				
Number of men employed exclusive of Mexico and South America	12,179	7,426	8,994	[a] 25,477
Total wages and salaries	$10,212,591	$11,205,547	$12,981,167	[b]
Average wage per day	$2.33	$4.19	$4.01	[b]
Charge smelted short tons	4,171,258	2,583,142	3,845,849	5,083,655
Bullion refined do	588,718	357,062	477,890	760,602
Coal used do	544,619	302,924	300,556	527,985
Coke used do	447,761	263,384	376,045	480,904
Fuel oil used barrels	976,528	758,937	1,145,212	1,927,055
Gas used cubic feet	7,430,300	837,012,321	1,684,226,523	3,427,713,457
Ore mined short tons	1,266,702	2,205,537	2,738,463	2,600,249
Coal mined do	257,942	360,952	460,144	543,634
Coke produced do	129,650	100,860	126,968	171,780

[a] Report does not specify "exclusive of Mexico and South America" in 1923.
[b] Not given.

ALASKA

Alaska first made a notable output of copper in 1903, producing 1,339,590 pounds in that year, and has been a steady producer ever since. Through 1923 the total smelter production has been 803,806,531 pounds, giving Alaska seventh rank among the copper-producing States, with 2.47 per cent of the total production of the country. In 1922 New Mexico ranked seventh with regard to total production. In 1923 Alaskan ores and concentrates yielded 68,648,368 pounds of blister copper, representing 4.78 per cent of the total for the country and giving Alaska fifth rank among the copper-producing States for the year. In 1922 also Alaska ranked fifth, with a production of approximately 6.30 per cent of the total for the country.

Prince William Sound.—The Beatson mine of the Kennecott Copper Corporation produced 399,628 tons of copper ore in 1923, having an average copper content of 1.598 per cent. The mill treated the entire quantity and produced 24,339.9 tons of concentrates with a copper tenor of 22.42 per cent, indicating a recovery for the year of 85.47 per cent, compared with 85.15 per cent in 1922. In 1922 the mill treated 274,863 tons of ore assaying 1.88 per cent of copper, which produced 23,147 tons of concentrates assaying 18.99 per cent of copper.

Copper River district.—The Bonanza and Jumbo mines of the Kennecott Copper Corporation produced 171,022 tons of ore assaying 11.62 per cent of copper in 1923, compared with 205,616 tons averaging 9.15 per cent in 1922. The mill treated 142,764 tons of this ore, which yielded 19,629.14 tons of concentrates assaying 44.7 per cent copper. In 1922 the mill treated 182,767 tons of

ore assaying 6.47 per cent of copper, from which 18,777 tons of concentrates averaging 49.03 per cent of copper were produced. The leaching plant produced 2,160 tons of precipitates containing 1,599 tons of copper. The total recovery of copper in all ores treated in milling and leaching was 92.34 per cent, compared with 87.29 per cent for 1922. Additions to the concentrator at Kennicott, completed in April, give the mill a capacity of 1,200 tons a day. At the mill and leaching plant shortage of labor during the spring and summer was more severe than usual. The corporation sold 50,945,719 pounds of copper and 378,572.46 ounces of silver from this district and Prince William Sound during the year. The average price received for the copper was 14.896 cents a pound, an increase from 13.605 cents in 1922. The cost of producing copper delivered to consumer, after charging depreciation and taxes and crediting silver and miscellaneous earnings, but without allowance for depletion, amounted to 8.35 cents a pound. This was a decrease from 8.67 cents a pound in 1922. During the year $3 a share was disbursed to stockholders in equal quarterly payments. No refined copper remained unsold and on hand at the end of the year.

The Mother Lode Coalition Mines Co. mined 156,195 tons of ore averaging 11.67 per cent of copper and 1.78 ounces of silver to the ton. A total of 32,606 tons containing 32,966,300 pounds of copper and 251,761 ounces of silver was shipped to the smelter. This was made up of 12,055 tons of high-grade ore, assaying 61.57 per cent of copper, and 20,551 tons of concentrates, assaying 44.45 per cent. The development program for the year was considerably curtailed owing to the scarcity of miners during the spring and summer and the concentration of available labor on increased production and necessary work in the new incline. Construction work completed in the early part of 1923 permitted an increase of 100 per cent in the concentrates produced during the year. The cost of producing copper delivered to consumer, after charging depreciation and taxes and crediting silver, was 7.08 cents a pound, compared with 6.90 cents in 1922. The average price for silver was only 76.376 cents an ounce, as compared to 99.524 cents in 1922, owing to the expiration of the silver purchases under the Pittman Act. This decrease and the greater proportion of concentrates shipped accounted for the increase in cost of copper production.

ARIZONA

Inclusive of 1923, Arizona has made a total smelter production of 9,544,620,128 pounds of copper since 1845. This is the largest production for a single State and represents 29.37 per cent of the total for the country. In 1923 Arizona produced 615,493,561 pounds of copper, 42.89 per cent of the total for the country, compared with 428,200,634 pounds in 1922, representing 45.06 per cent. Arizona is thus shown to be by far the largest copper-producing State, her nearest competitor, Montana, having produced only 15.64 per cent of the total for the country in 1923.

Bisbee district.—The copper production of the Bisbee district for 1923 and several preceding years is given in the following table:

Copper produced in Bisbee district, Ariz., 1918–1923

Year	Pounds	Average yield in copper (per cent)	Value in gold and silver per ton
1918	160,456,000	4.9	$1.62
1919	122,311,000	4.87	2.21
1920	118,448,000	4.06	1.81
1921	37,249,000	4.81	3.00
1922	79,591,000	5.15	3.25
1923	123,884,000	3.59	1.54

The Copper Queen branch of the Phelps Dodge Corporation is always the largest producer in the Bisbee district. Production was maintained at approximately 60 per cent of capacity throughout the year by this company. The Copper Queen mines produced 87,935,334 pounds of copper, compared with 47,962,123 pounds in 1922. A total of 221,383,152 pounds of copper was delivered to buyers at an average price of 14.23 cents a pound, net cash, f. o. b. New York during 1923. Of this total, 171,307,759 pounds was taken by domestic trade and 50,075,393 pounds by foreign trade. In addition 4,964,008 pounds of copper, the remainder of the metal taken over with the properties of the Arizona Copper Co. (Ltd.), was sold by the United Metals Selling Co. for the account of the Phelps Dodge Corporation.

At the limestone mines, as in 1922, the work was confined as much as possible to the Southwest and Sacramento divisions in order to obtain the advantage of as much centralization as possible. Development workings aggregating 36,226 feet were driven in copper areas, representing an increase of 12,000 feet as compared with 1922. The company states that although the smelting ore reserves were increased in the Southwest Extension, Uncle Sam, and Higgins areas and at other less important points, an estimate of the total reserves at the end of the year shows a shrinkage as compared with last year's figures for the limestone mines.

Production from the west porphyry ore body of Sacramento Hill began during the year. A total of 1,481,671 cubic yards of ore and waste was removed from it, of which 1,005,842 yards went to the waste dump; of the remainder 434,239 tons, assaying 0.93 per cent copper, was put on the leach dump, 596,384 tons went to the mill, 39,519 tons to the stock pile, and 17,564 tons consisted of direct smelting ores.

The first unit of the new mill was placed in operation on April 2, and the others followed as completed and as required. A total of 615,177 tons of ore averaging 1.83 per cent of copper was treated, from which concentrates averaging 7.82 per cent copper and tailings averaging 0.25 per cent were produced.

County and State taxes amounting to the equivalent of about 1 cent a pound were paid at the Copper Queen branch in 1923. Regular dividends aggregating 4 per cent were declared during the year by the Phelps Dodge Corporation.

Metals produced by Copper Queen Consolidated Mining Co., 1918–1923

Year	Ore	Copper	Silver	Gold	Lead	Zinc
	Short tons	*Pounds*	*Ounces*	*Ounces*	*Pounds*	*Pounds*
1918	771,063	90,988,156	558,433	16,409	1,234,497	----------
1919	606,386	68,614,002	492,326	10,813	9,372	----------
1920	832,172	71,443,396	486,698	8,846	243,836	----------
1921	515,632	30,610,173	495,179	4,650	4,916,418	----------
1922	389,367	47,962,123	1,132,304	11,972	8,560,525	247,793
1923	1,189,570	87,935,334	935,729	19,151	6,307,412	610,709

Metals produced by Copper Queen branch of Phelps Dodge Corporation, 1923

	Ore, dry weight	Gold	Silver	Copper	Lead	Zinc
Underground:						
Company—	*Short tons*	*Ounces*	*Ounces*	*Pounds*	*Pounds*	*Pounds*
Copper ore	371,541	7,168	343,875	49,321,995	----------	----------
Silver ore	644	59	10,288	4,960	----------	----------
Lease—Copper ore	125,958	5,386	188,186	12,356,456	----------	----------
	498,143	12,613	542,349	61,683,411	----------	----------
Company—Lead ore	17,194	1,251	221,050	10,421	2,819,195	----------
Lease—Lead ore	16,038	191	93,746	945,492	3,272,420	----------
	33,232	1,442	314,796	955,913	6,091,615	----------
Lease—Lead-zinc ore	1,313	----------	----------	----------	215,797	610,709
	532,688	14,055	857,145	62,639,324	6,307,412	610,709
Sacramento Hill:						
Company—						
Smelting ore	17,564	354	5,035	1,648,578	----------	----------
Milling ore	635,903	4,717	72,186	23,267,904	----------	----------
	653,467	5,071	77,221	24,916,482	----------	----------
Lease—Copper ore	3,261	25	1,356	246,473	----------	----------
	656,728	5,096	78,577	25,162,955	----------	----------
Precipitates	154	----------	7	133,055	----------	----------
Total production	1,189,570	19,151	935,729	87,935,334	6,307,412	610,709

Production by the Calumet & Arizona Mining Co. was maintained throughout the year at about 60 per cent of capacity. The smelter production for the year averaged about 3,900,000 pounds of fine copper a month, from company, lease, and custom ores. The company has had to resort entirely to reverberatory smelting on account of continual changes in character of the ores from the Bisbee mines. Consequently, when the original fine-crushing plant was found to be inadequate to handle the entire tonnage, appropriations for a fine-crushing plant, a new sampling plant, and Cottrell treaters at the roaster plant and at the converters were approved. Work on these improvements was 70 per cent complete at the end of the year. The installation will aid in the reduction of converter costs and metal losses. Owing to the high prices received for copper in the beginning of the year, wages were increased 10 per cent, but when the prices dropped to 13 cents a pound and lower it was necessary to cut this increase. The company mined 491,565 wet tons of ore in 1923, of which 439,959 tons was treated at the Calumet & Arizona smelter at Douglas, 36,690 tons of exchange ore at the Copper Queen smelter at Douglas, 10,667 tons of low-copper high-sulphur ore at the Old Dominion smelter at Globe, and 3,630 tons of lead-silver

ore at the smelter of the Kansas City Smelting & Refining Works at El Paso. At the end of the year 619 tons of ore was in transit. The average copper content of ore shipped to the Calumet & Arizona smelter at Douglas for the year was 4.62 per cent, compared with 4.76 per cent in 1922.

Metals produced by Calumet & Arizona Mining Co., 1918–1923

Year	Refined copper produced (domestic)	Gold	Silver	Dividends
	Pounds	*Ounces*	*Ounces*	
1918	50, 909, 373	31, 308	906, 210	$5, 140, 062
1919	44, 991, 107	28, 530	995, 366	1. 927, 563
1920	42, 430, 847	32, 520	932, 489	2, 570, 084
1921	17, 855, 613	12, 365	419, 647	1, 285, 043
1922	30, 830, 615	23, 349	642, 174	1, 285, 047
1923	42, 166, 930	35, 693	824, 768	2, 248, 849

Operations were resumed by the Shattuck Arizona Copper Co. on February 9, 1923. By April 3 sufficient repairing had been done to allow the stopes on the 100 and 600 foot levels to be reopened, and copper shipments at the rate of 50 tons a day commenced. The shipments were increased to 150 tons a day, but with the drop in price to 13 cents a pound and lower, they were reduced again to 50 tons. By the utmost economy, in spite of operating below capacity and other drawbacks, the company produced copper at 6.926 cents a pound, as compared with 7.22 cents for the year 1913. This cost, the company states, is computed after credits are allowed for gold and silver but before depletion, depreciation, and deferred-development charges are deducted.

Metallic production of the Shattuck Arizona Copper Co. in 1923

Copper ore mined	wet short tons	26, 443. 52
Copper ore shipped	do	26, 348. 24
Copper ore smelted	do	26, 286. 69
Average moisture in copper ore	per cent	4. 56
Silica and lead ores mined	wet short tons	22, 937. 67
Silica and lead ores shipped	do	22, 562. 67
Silica and lead ores smelted	do	19, 141. 54
Average moisture in silica and lead ores	per cent	3. 54
Copper recovered	pounds	3, 223, 209
Copper recovered per dry ton	do	128. 472
Gold from copper ores	ounces	1, 349
Silver from copper ores	do	157, 124
Lead recovered	pounds	1, 590, 682
Gold from lead ores	ounces	1, 023
Silver from lead ores	do	164, 354
Gross copper operating cost	cents per pound	11. 477
Operating credits (copper)	do	4. 551
Net copper operating cost	do	6. 926
Average price received for copper	per pound	16. 129

Metals produced by Shattuck Arizona Copper Co., 1918–1923

Year	Copper	Silver (from copper ores)	Gold (from copper ores)	Lead	Copper recovered	Dividends
	Pounds	*Ounces*	*Ounces*	*Pounds*	*Per cent*	
1918	9,081,959	161,230	1,220	2,420,690	4.83	$437,500
1919	2,111,841	89,724	300	4,432,655	4.74	[a] 262,500
1920	2,374,148	73,718	575	8,254,603	6.19	
1921 [b]	287,928	12,093	29		7.94	
1922						
1923	3,223,209	157,124	1,349	1,590,682	6.42	

[a] Capital distribution through 1923 to the amount of $1,487,500.
[b] Result of development work only. No productive operations carried on.

Globe-Miami district.—The production of the Globe-Miami district in 1923 and several preceding years is given below.

Copper produced in Globe-Miami district, Ariz., 1917–1923

Year	Copper	Yield of ore in copper	Year	Copper	Yield of ore in copper
	Pounds	*Per cent*		*Pounds*	*Per cent*
1917	169,490,000	1.42	1921	76,488,000	1.33
1918	201,806,000	1.31	1922	170,035,000	1.36
1919	171,106,000	1.36	1923	198,426,000	1.24
1920	176,215,000	1.20			

The Old Dominion Co. delivered 28,443,060 pounds of refined copper to buyers at an average price of 14.253 cents a pound net cash f. o. b. New York. All the company's copper is sold by the Phelps Dodge Corporation. The company states that the average grade of its ore reserves compares closely with the average grade of ore mined in 1923, as shown in the table below. The content of concentrating ore is lower and that of smelting ore is higher than the grade shown. In the concentrating department 272,454 tons of ore averaging 4.52 per cent of copper was milled, and 106,994 tons of charge was treated in the smelter.

Ore produced by Old Dominion Co., 1923

	Short tons	Percentage of copper
Smelting ore	78,111	7.54
Concentrating ore	207,575	4.02
Converting ore	4,009	2.64
	289,695	4.95

Metals produced by Old Dominion Co.,[a] 1918–1923

Year	Ore	Copper	Gold	Silver	Average grade of ore in copper	Dividends
	Short tons	*Pounds*	*Ounces*	*Ounces*	*Per cent*	
1918	230,451	33,378,158	5,071	184,982	4.52	$1,188,284
1919	253,686	28,166,396	5,756	137,071	4.28	----------
1920	249,111	22,854,452	3,484	181,010	4.79	----------
1921	61,753	7,389,648	1,187	71,155	5.31	----------
1922	202,954	18,573,289	3,517	122,095	5.14	----------
1923	289,695	26,764,801	5,137	190,033	4.95	----------

[a] Includes custom metals produced.

The production of copper by the Miami Copper Co. in 1923 was only a little below that for 1922, which was the highest in the history of the company. The cost of operations at the property was 8.5 cents a ton greater than in 1922, which, coupled with a lower yield, resulted in an increase of 1.2 cents a pound of refined copper. The company states, however, that the price received per pound was higher than in 1922 and that the net profit showed an increase. Changes in the flow sheet of the mill were carried into effect during the year and resulted in a larger tonnage capacity, as well as a greater saving of sulphide copper. The higher content of oxide copper in the feed during the year was the cause of the lower extraction in 1923. Developments during the year added 308,133 tons to the reserves of high-grade sulphide ore bodies, and mining operations extracted 420,978 tons from areas outside the previously estimated boundary, so that a total of 729,111 tons was added to reserves. Four quarterly dividends, aggregating $2 a share, were paid in 1923.

Copper produced by Miami Copper Co., 1918–1923

Year	Ore	Copper content	Mill extraction	Refined copper	Dividends
	Short tons	*Per cent*	*Per cent*	*Pounds*	
1918	2,132,941	2.026	71.15	58,407,563	$3,362,013
1919	1,698,446	2.04	82.38	54,221,638	1,867,785
1920	1,801,958	1.968	82.48	55,581,328	1,494,228
1921	1,868,757	1.758	85.37	53,311,941	1,494,228
1922	2,183,020	1.883	86.36	67,454,447	1,494,228
1923	2,380,155	1.697	83.98	64,448,345	1,494,228

Milling operations of Miami Copper Co., 1923

Ore milled	short tons	2,380,155
Copper in ore	per cent	1.697
Concentrates produced	short tons	80,807
Copper in concentrates	per cent	41.977
	pounds	67,840,363
Copper recovered per ton of ore	do	28.503
Mill extraction	per cent	83.98

Cost of copper in concentrates f. o. b. cars at Miami, Ariz., 1923

	Per ton of ore	Per pound of copper
Mining	$1.23071	$0.04531
Milling	.62103	.02286
General	.28948	.01066
	2.14122	.07883

Ore reserves of Miami Copper Co., January 1, 1924

	Short tons	Percentage of copper
High-grade sulphide ore	5,106,643	2.08
Mixed sulphide and oxide ore	6,000,000	2.00
Low-grade sulphide ore	36,000,000	1.06
	47,106,643	

The Inspiration Consolidated Copper Co. produced copper at an average monthly rate of 7,406,751 pounds in 1923. The ore mined during the year contained an average of 1.192 per cent of copper. The company stated that the extensive development of the Live Oak ore body, the sinking and preparation of the Porphyry shaft, the surface equipment and extension of the railroad to handle this ore, and the construction of a town site to house employees, calling for an expenditure of over $5,000,000, would be completed in July, 1924, and that the average grade of ore mined should then increase, owing to the higher grade of the ore in the Live Oak section. The quantity of ore mined per man shift for all labor chargeable to mining ore increased from 14.5 tons in 1922 to 16.0 tons in 1923. The experimental plant was operated from January 15 to December 15, and during that time a total of 5,086 tons of ore was treated. The cost of fine copper produced during the year, including depreciation but excluding depletion and Federal taxes, amounted to 11.6158 cents a pound of copper.

Mill statistics, Inspiration Consolidated Copper Co., 1923

Total ore milled—dry tons	5,123,100
Ore milled per day—do	14,232
Average number of sections running	15
Average rate per section—tons	963
Screen analysis of feed (on 48 mesh)—per cent	4.9
Assay mill feed—per cent of copper	1.175
Copper in feed, oxidized—per cent	.249
Copper assay of general tailings—do	.303
Copper in general tailings, oxidized—do	.231
Copper in general concentrates, smelter assay—do	27.15
Copper in flotation concentrates—do	32.24
Copper in table concentrates—do	9.28
Moisture in general concentrates—do	15.24
Ratio of concentration	31.0
Recovery of copper (calculated from smelter assays):	
Assays only—per cent	75.05
Assays and weights of concentrates and ore—do	74.56
Assays and weights of concentrates and tailings—do	74.92
Assays and weights of ore and tailings—do	75.05

Recovery of copper sulphides	per cent	92.48
Water used per ton of ore	tons	1.875
Power used per ton of ore milled:		
Coarse crushing	kilowatt-hours	.49
Fine grinding and concentrating	do	10.37
Blowers for flotation air	do	2.22
Filtering and reclaiming water	do	.84
Lighting	do	.11
		14.03
Steel balls consumed per ton of ore milled	pounds	1.64
Flotation oil consumed per ton of ore milled:		
Coal tar	do	0.899
Other oils	do	.103
		1.002

Copper produced by the Inspiration Copper Co., 1923

	Ore treated (tons)	Copper produced (pounds)
Inspiration concentrating ore	5,060,474	85,745,113
Live Oak concentrating ore	62,626	1,069,036
Inspiration ore to smelter	1,179.8	21,348
Warrior ore to smelter	15,509.1	1,794,147
Live Oak ore to smelter	2,085.0	106,203
Live Oak and Inspiration ores to leaching test	4,876.3	145,165
	5,146,750.2	88,881,012

The mine and mill of the Iron Cap Copper Co. were operated continuously throughout 1923. The plant was reported to be in first-class condition and was operated at a cost 44 cents a ton lower than in 1922.

Metallic production of the Iron Cap Copper Co., 1919–1923

	1919	1920	1921	1922	1923
Ore (dry weight) short tons	64,540	91,326	4,424	69,675	83,931
Silver recovered and sold ounces	104,458	113,323	4,002	72,005	75,982
Copper recovered pounds	7,156,270	8,235,670	385,548	5,829,122	6,134,162
Average price received:					
Per ounce of silver	$1.104	$1.083	$1.015	$0.9952	$0.77826
Per pound of copper	.18918	.17444	.12580	.13425	.14446

Result of mill operation of the Iron Cap Copper Co., 1923

Ore milled (dry)	short tons	83,931
Average assay of feed	per cent of copper	4.12
	ounces of silver per ton	1.16
Copper contained in ore	pounds	6,910,271
Silver contained in ore	ounces	97,758
Concentrates produced (dry)	short tons	12,551
Average assay of concentrates	per cent of copper	25.74
	ounces of silver per ton	6.73
Copper contained in concentrates	pounds	6,462,445
Silver contained in concentrates	ounces	84,425
Tailings rejected (dry)	short tons	71,380
Average assays of tailings	per cent of copper	0.313
	ounce of silver per ton	0.187

Copper contained in tailings	pounds	447, 826
Silver contained in tailings	ounces	13, 332
Recovery of copper	per cent	93. 52
Recovery of silver	do	86. 36
Operating cost per dry short ton		$1. 80

The Copper Hill mine of the Arizona Commercial Mining Co. was operated throughout the year, but the Eureka mine remained idle. The company reports that although its ore reserves at the end of 1923 were not as large as at the end of 1922, they are estimated to be sufficient at the present rate of production to last at least four years. A dividend of 50 cents a share was paid during the year.

Copper, gold, and silver produced by the Arizona Commercial Mining Co., 1919-1923

Year	Refined copper	Gold	Silver
	Pounds	*Ounces*	*Ounces*
1919	7, 280, 861	1, 310	16, 918
1920	7, 913, 836	1, 722	31, 028
1921	572, 616	163	3, 001
1922	6, 220, 923	1, 585	27, 532
1923	8, 115, 212	2, 143	37, 826

The Superior & Boston Copper Co. produced 1,709,670 pounds of copper in the fiscal year ending September 30, 1923, the largest output since 1914, when approximately 3,000,000 pounds was produced. The company averaged 1 foot of development work for every 3 tons of ore mined, which it claims is considerably above the average for the district. Silver contents of the year's shipments amounted to 205,659 ounces, the largest in the company's history.

Morenci-Metcalf district.—The production of the Morenci-Metcalf district for several years, including 1923, is shown below.

Copper produced in Morenci-Metcalf district, 1917-1923

Year	Pounds	Average yield of copper from ore (per cent)	Year	Pounds	Average yield of copper from ore (per cent)
1917	53, 000, 000	1. 85	1921	11, 420, 000	1. 47
1918	71, 867, 000	1. 71	1922	14, 175, 000	2. 76
1919	44, 868, 000	1. 72	1923	28, 735, 000	2. 19
1920	35, 746, 000	1. 73			

The Morenci branch of the Phelps Dodge Corporation produced 28,327,635 pounds of copper in 1923. In May work was started on the remodeling of the concentrator to provide a capacity of 4,500 tons a day. Up to April the ores and concentrates produced were shipped to the Douglas smelter, but on May 1 the Clifton smelter was started. The No. 6 concentrator treated 616,222 tons of ore averaging 2.4 per cent of copper. The recovery from sulphide copper was 91.91 per cent and from total copper 81.91 per cent.

Metal production of the Morenci branch of the Phelps Dodge Corporation in 1923

	Ore, dry weight	Copper contained	Silver	Gold
	Short tons	*Pounds*	*Ounces*	*Ounces*
Mine, company and lease ore	641,757	33,844,015	[a]	[a]
Concentrator, concentrates	56,844	24,510,827	[a]	[a]
Clifton smelter, blister copper		22,201,180	42,172.81	1,412.219
Douglas smelter, blister copper		6,126,455	11,068.61	35.681
		28,327,635	53,241.42	1,447.900

[a] Not shown.

The production of the Arizona Copper Co. from 1916 until it was taken over by the Phelps Dodge Corporation is shown below:

Copper produced by Arizona Copper Co., 1916–1921

Year ending Sept. 30—	Ore treated	Copper produced	Average yield
	Short tons	*Pounds*	*Per cent*
1916	905,486	34,100,000	1.803
1917	1,178,087	42,482,000	1.830
1918	1,095,568	40,442,000	1.754
1919	1,147,659	36,474,000	1.611
1920	1,046,331	35,692,000	1.642
1921 [a]	573,397	18,550,000	1.701

[a] Figures are for 8 months ending May 31, 1921, when plant was shut down.

Jerome district.—The production of copper in the Jerome district in 1923 and in several preceding years is given in the table below. The principal producers of the district are the United Verde Copper Co. and the United Verde Extension Mining Co.

Copper produced in the Jerome district, Ariz., 1916–1923, in pounds

1916	102,000,000	1920	107,084,000
1917	145,900,000	1921	26,568,000
1918	133,781,000	1922	74,794,000
1919	72,333,000	1923	140,425,000

The United Verde Copper Co. has almost completed a new crushing plant.

In 1923 the United Verde Extension Mining Co. produced 41,855,959 pounds of copper, of which 11,444,724 pounds was on hand December 31, 1923. The ore reserves of the company above the 1,600-foot level are estimated to be 940,786 tons, averaging 9.97 per cent of copper and 0.031 ounce of gold and 2.05 ounces of silver to the ton. The average cost per pound of copper produced, shown in detail below, was 7.27 cents exclusive of depreciation, reserve to return capital (depletion), and taxes, compared with 6.93 cents a pound in 1922.

Cost of producing copper by United Verde Extension Mining Co., in 1923

Mining	cents per pound	2.72
Smelting	do	2.31
Freight on ore	do	.08
Freight on bullion, refining, selling	do	2.08
Other expenses	do	.08
		7.27

Copper produced by the United Verde Extension Mining Co., 1918–1923

Year	Ore treated	Copper produced	Silver	Gold
	Short tons	*Pounds*	*Ounces*	*Ounces*
1918	133,535	55,491,077	503,739	3,046
1919	93,325	28,860,615	272,855	3,169
1920	161,617	41,942,700	359,370	5,530
1921	53,643	12,498,005	112,864	2,328
1922	136,980	31,640,714	238,764	5,788
1923	172,629	41,855,959	257,602	8,992

The Humboldt smelter of the Southwest Metals Co. was operated in 1923.

Ray or Mineral Creek district.—The Ray Consolidated Copper Co. acquired the properties and assets of the Chino Copper Co. February 15, 1924, and the result will be more economical operation of the mines and plants of both companies. No dividends were distributed to stockholders during 1923, but since the beginning of operations cash distributions to Ray mine stockholders have aggregated $25,412,620.67. By deducting the ore mined during 1923 from the quantity reported as reserves at the beginning of the year, the developed ore reserves at the end of the year stand at 78,762,296 tons. The total concentrating ore produced and milled from the Ray properties since the beginning of operations is 27,769,449 tons. From this ore and a comparatively small quantity shipped direct to the smelter 658,981,062 pounds of copper has been produced. The mining cost for the year was $1.09 a ton, compared with 99 cents for 1922. This does not include depreciation nor the usual charge of 15 cents a ton to cover extinguishment of mine-development expense. At the Hayden mill two sections have been remodeled and the company states that these sections are treating approximately 20 per cent more than the regular sections, with improved metallurgical results and lower operating costs. The work of similarly remodeling the other sections is in progress. Concentrates amounting to 187,286 tons containing an average of 16.89 per cent of copper were produced during the year. The recovery from copper occurring in the form of sulphides averaged 83.18 per cent for the year, and the recovery from the carbonates and other oxidized copper minerals, which are not readily amenable to water concentration, was 30.87 per cent.

Copper produced by Ray Consolidated Mining Co., 1918–1923

Year	Ore milled	Copper content	Mill recovery	Refined copper	Cost per pound [a]	Dividends and capital distributions
	Short tons	*Per cent*	*Per cent*	*Pounds*	*Cents*	
1918	3,411,000	1.613	74.92	83,599,160	17.695	5,125,831
1919	1,621,600	1.814	79.45	46,011,371	15.62	3,154,358
1920	1,706,928	1.720	81.98	47,062,030	16.144	1,577,179
1921	406,172	1.646	77.82	10,110,131	16.41	----------
1922	1,178,350	1.587	76.66	27,953,408	[b] 12.41	----------
1923	2,689,800	1.571	74.87	61,385,205	[b] 12.03	----------

[a] Does not include amount received for gold and silver or miscellaneous income.
[b] Includes amount received for gold and silver and miscellaneous income but not charges for depreciation. Comparative value for 1921 was 16.25 cents.

Ajo district.—The New Cornelia Copper Co. mined and delivered to the crushing plants for leaching operations 1,805,322 tons of carbonate ores averaging 1.532 per cent of copper. Leaching operations were conducted on a uniform basis, and the cost per pound was considerably lower than for any previous year. Because it was necessary to treat a larger percentage of mixed ores, owing to mining on the contact of the carbonate and sulphide zones, extractions were lower, but the company reports that the results were very satisfactory. Work on the new 5,000-ton concentrator, which was begun in October, 1922, progressed during the year, and the first unit was put in operation on January 8, 1924. The carbonate ores of the New Cornelia Copper Co. are reported to be sufficient for approximately three years longer. Dividends of $1,350,000, of which $450,000 was capital distribution, were paid during the year.

Copper produced by the New Cornelia Copper Co., 1920–1923, in pounds

	1920	1921	1922	1923
Electrolytic copper	37,331,586	19,993,758	26,408,610	36,063,832
Copper in cement copper shipped	2,113,985	169,035	140,732	2,303,886
Copper in ore shipped	249,353	35,589	63,461	----------
Copper in concentrates shipped	409,569	----------	----------	----------
	40,104,493	20,198,382	26,612,803	38,367,718

Pioneer district.—The Magma Copper Co. produced 78,889 tons of ore in 1923, of which 9,272 tons, averaging 15.995 per cent of copper, was direct smelting ore. The mill recovery was 92.43 per cent of the total copper in the mill heads. The total copper recovered, including direct smelting ore, was 95.13 per cent of the copper content of the run-of-mine ore. From the concentrates and direct smelting ore shipped to the Hayden plant of the American Smelting & Refining Co., after deducting smelting and refining losses, 6,956,576 pounds of copper, 204,081 ounces of silver, and 2,567 ounces of gold were produced. During the year the concentrator was remodeled so as to double its capacity, the present capacity of each of the three sections being 200 tons a day. Work on the new smelter of the company progressed well during the year, and the first roasted ore and concentrates were put into the furnace on March 21, 1924. Smelting capacity for 3,000,000 pounds a month was provided in

the plant. By increasing the percentage of copper in the smelting charge to a point not higher than the average of past shipments to custom smelters, it is possible, according to the company, to increase the capacity of the present plant to nearly 4,000,000 pounds a month. The plant embodies advanced ideas in smelter design and is the first new smelter constructed in the United States since the United Verde Extension Mining Co.'s plant was put in operation in July, 1918.

CALIFORNIA

In 1923 California produced 27,042,835 pounds of copper and ranked eighth among the copper-producing States of the country, with 1.88 per cent of the total production. From the beginning of operations in 1862 through 1923 California's production has been 843,668,318 pounds of copper, or 2.60 per cent of the total production for the United States. Thus California ranks sixth among the copper-producing States in total production. Although the Plumas district is now the largest producer in the State, both the Shasta and Foothill districts have made larger total outputs.

Shasta district.—The total production of copper in the Shasta district, inclusive of 1923, has been 579,131,000 pounds, 1.78 per cent of the total for the country.

The Mammoth mine and smelter of the United States Smelting, Refining & Mining Co., which have been idle for several years, were prepared in 1923 for a resumption of operations. One furnace was started late in November. Up to the end of the year 13,443 tons of ore was smelted. Additional geologic study of the mine suggested certain exploratory work, which is in progress, and the company hopes it will uncover additional ore.

Early in the fall of 1923 the Mountain Copper Co. (Ltd.) resumed operations at its mine and smelter and produced 907 tons of blister copper. Later in the year, owing to the low price of copper, operations were discontinued. The company believes that resumption of operations, when it occurs again, will not be nearly so expensive or take so long as it did in 1923.

Foothill district.—The Foothill district did not produce any copper in 1921 or 1922 but yielded 1,598,726 pounds in 1923, most of which was from Calaveras County.

Plumas district.—The Engels Copper Mining Co., which is by far the largest producer in the Plumas district, produced 14,450,243 pounds of copper, 165,441 ounces of silver, and 2,592 ounces of gold in 1923. This compares with a copper production for 1922 of 14,075,947 pounds. The net operating cost was 11.35 cents a pound, or 12.93 cents after adding reserves for depreciation, compensation insurance, and amortization of development charges, as shown below, compared with 11 and 12.21 cents in 1922, an increase for 1923 of 0.72 cent a pound. The increase is due to decreased credits on account of the drop in the price of silver and increased charges for depreciation and amortization of development costs.

Cost of producing copper by Engels Copper Mining Co., 1923

		Total	Per pound of copper
			Cents
Ore on cars at Engels		$1,078,802.80	7.4656
Freight and smelting charges	$735,679.63		
Credit value of gold and silver recovered	174,844.77		
		560,834.86	3.8811
Operating and marketing cost		1,639,637.66	11.3467
Cost of depreciation and insurance, reserves, and development		228,935.62	1.5843
		1,868,573.28	12.9310

The company reports that the No. 10 level project is nearing completion, and that excellent bornite ore has been disclosed on this level, assuring a material increase in proved ore reserves when the intermediate levels are opened. Experimental work carried on throughout the year in an effort to improve operating practice resulted in an increase of 1.557 per cent in the percentage extraction of copper in the mill over that in 1922.

Operations at Superior mill, 1923

Ore milled	short tons	381,420
Average heads	per cent	2.1347
Average tails	do	.2459
Actual extraction	do	88.737
Concentrates produced	pounds	49,838,787
Average content of concentrates	per cent	28.994
Copper produced	pounds	14,450,243
Silver produced	ounces	165,444.76
Gold produced	do	2,591.81

Ore reserves of Engels and Superior mines, December 31, 1923, in short tons •

Mine	Blocked ore		Probable ore	Total
	In place	Broken in stopes		
Engels	873,243	233,375	646,800	1,753,418
Superior	416,850	149,797	250,000	816,647
	1,290,093	383,172	896,800	2,570,065

• Estimate includes ore in pillars.

The company states that the above estimate of ore reserves is based on a technical interpretation of the conditions as found in the mines December 31, 1923, and should not be construed to mean that it includes all ore, both probable and possible, that is contained in the mines.

The mines of the Walker Mining Co., a subsidiary of the Anaconda Copper Mining Co., were operated throughout the year, and 166,953 tons of ore was broken. The new concentrator, with a capacity of 750 tons of ore a day, completed during the year and put in operation in November, treated 87,041 tons of ore averaging 4.123 per cent of copper, from which 14,566.64 tons of concentrates averaging 22.782

per cent of copper were produced. The mill recovery averaged 95.58 per cent. The company shipped to the smelter 14,087 tons of concentrates containing 6,634,368 pounds of copper and 7,591 tons of crude ore averaging 9.75 per cent of copper.

COLORADO

The production of blister copper from Colorado ores and concentrates in 1923 amounted to 4,343,418 pounds, compared with 3,635,916 pounds in 1922. This represented 0.30 per cent of the total output of the country and gave Colorado tenth rank among the copper-producing States. In total production since 1845 Colorado also ranks tenth, with a production of 298,584,520 pounds, or 0.92 per cent of the total for the country. Colorado's copper output is derived mainly from the treatment of mixed ores in which copper is a minor constituent, including lead-silver ores and pyritic ores rich in gold and silver. There is in the State no important district, now producing, in which copper is the principal valuable metal.

IDAHO

From the beginning of operations through 1923 Idaho has made a total smelter production of 121,619,638 pounds of copper, which represents 0.37 per cent of the total output of the country and ranks Idaho eleventh among the copper-producing States. In 1923 Idaho's output was 3,664,079 pounds of copper, or 0.26 per cent of the total for the country, compared with 3,504,944 pounds, or 0.37 per cent of the total, in 1922. The output of the State comes principally from the Alder Creek district.

MICHIGAN

In total smelter output of copper from the beginning of operations through 1923 Michigan ranks third among the copper-producing States, with a production of 7,221,614,536 pounds, or 22.23 per cent of the total for the country. Arizona and Montana are the only States that have made a larger total production than Michigan, but in 1923 Utah displaced Michigan for third place. In 1923 Michigan produced 137,691,306 pounds of copper, or 9.60 per cent of the country's total output. This was an increase from 122,545,126 pounds in 1922, but in 1922 Michigan ranked third and her production represented 12.90 per cent of the total.

Lake Superior district.—Figures of copper ore produced for several years in the Lake Superior district, ending with 1923, are shown below.

Copper ore produced in Lake Superior district, Mich., 1917–1923

Year	Short tons	Yield of copper (per cent)	Year	Short tons	Yield of copper (per cent)
1917	12,400,723	0.99	1921	3,610,648	1.20
1918	11,321,365	.96	1922	4,952,264	1.23
1919	7,690,253	1.16	1923	5,363,160	1.39
1920	5,938,967	1.30			

The consolidation of the Ahmeek, Allouez, Calumet & Hecla, Centennial, and Osceola Consolidated mining companies to form the Calumet & Hecla Consolidated Copper Co. became effective September 1, 1923. Up to the time of the consolidation the Ahmeek mine had produced 17,811,031 pounds of copper in 1923, the Calumet & Hecla mine 24,413,600 pounds, and the Calumet & Hecla reclamation plant 10,634,200 pounds; after the consolidation, during the remaining four months of the year, the mines produced 21,259,000 pounds and the reclamation plant 6,267,000 pounds of copper. The total for the group, for the year, was 80,384,831 pounds.

At the Calumet mill an average of 8 out of the 11 stamp units in the plant treated the conglomerate rock; the Hecla mill, of 17 stamp units, remained closed throughout the year. The Ahmeek mill treated the Kearsarge lode rock and the output of the Seneca Copper Corporation. This mill operated at less than 50 per cent of capacity. The electrolytic plant of the company has not been in commission since December, 1922, as the silver content of the copper is not enough to pay for its recovery. The Lake Milling, Smelting & Refining Co., 52 per cent of whose stock is owned by the Calumet & Hecla Consolidated Copper Co., remained idle during the entire year.

The Isle Royale Copper Co. treated 308,940 tons of rock in 1923, which yielded 8,002,244 pounds of refined copper, at the rate of 25.90 pounds per ton of rock treated. The cost of producing this copper, including depreciation and depletion, was 16.26 cents a pound.

The Cliff Mining Co., La Salle Copper Co., Superior Copper Co., and White Pine Copper Co. were idle during 1923.

A statement of the production of the Baltic and Trimountain mines and one-half the production of the Champion Mining Co. (owned by the Copper Range Co.) in 1923 and an average for 10 years is given below. The other half of the Champion Mining Co. is owned by St. Mary's Mineral Land Co.

Production of mines owned by Copper Range Co., 1923, and average, 1914–1923

	1923	Average, 1914–1923
Rock stamped ..... short tons..	368,639	786,165
Refined copper produced:		
Total ..... pounds..	14,365,045	25,481,510
Per ton stamped ..... do....	38.96	32.28
Cost per pound, including depreciation and depletion ..... cents..	19.07	15.84
Price received per pound ..... do....	14.81	19.34
Profit or loss per pound ..... do....	−4.26	+3.50

The Trimountain Mining Co. was dissolved in 1923, and the outstanding stock was acquired by the Copper Range Co., which now owns the mine. No attempt has been made at production here since December, 1922, when a large part of the underground force was transferred to the Champion mine, and therefore the development work in 1923 increased the reserves. The ore mined at Champion and from the Baltic main vein was offset by ore revealed by development work during the year. At the Baltic west vein, however, more was mined than was added to the reserves by development. The Copper Range Co. paid dividends of $394,425 during 1923.

On August 16, 1923, the Mohawk Mining Co. purchased the Wolverine and Michigan mines. The Mohawk mine produced a total of "mineral" and "mass" of 13,379,095 pounds, which yielded 70.65 per cent of refined copper, or 9,452,539 pounds, an extraction of 23.32 pounds of copper to the ton of rock stamped. The stamp mill has been in operation on an average of 80 per cent of its total capacity handling Mohawk and Wolverine rock. The Michigan mine has been idle since 1920. Since its purchase by the Mohawk Mining Co. the Wolverine mine has produced 1,694,320 pounds of "mineral" and "mass," which yielded 1,170,335 pounds of refined copper, an extraction of 16.82 pounds of copper to the ton of rock stamped. The company paid dividends amounting to $315,000 during the year.

The Quincy Mining Co. produced 22,371,330 pounds of "mineral" in 1923, yielding 13,000,733 pounds of refined copper. The mine was operated at about 60 per cent of normal capacity and work was confined to shafts Nos. 2 and 6. The company suffered from shortage of labor, which was general throughout this district and many other mining districts of the country. The exhaust-steam turbo-generator plant was put into full commission on April 16 and is reported to have operated with smoothness and economy exceeding expectations. This was demonstrated in January, 1924, when the plant stamped as much rock as was stamped in January, 1923, and generated as much electrical power as was consumed in January, 1923, with 640 tons less of coal.

Mine development by the Seneca Copper Corporation was advanced during 1923 and production was started on a small scale.

MONTANA

Only one State, Arizona, has produced more copper than Montana since 1845. Arizona has produced 9,544,620,128 pounds of blister copper and Montana 8,451,089,649 pounds, which represent 29.37 and 26.01 per cent of the total for the country. In output for 1923 also Montana was second only to Arizona, with a production of 224,353,764 pounds, or 15.64 per cent of the total for the country. In 1922 Montana produced 165,341,414 pounds of copper, or 17.40 per cent of the total. The Butte district furnishes almost the entire production of the State.

Butte district.—The Butte district has produced more copper than any other one district in the United States. The Anaconda Copper Mining Co. has been the largest contributing factor in the production of this district.

Copper and associated metals produced in Butte district, Mont., 1918–1923

Year	Copper	Average yield in copper	Gold	Silver
	Pounds	*Per cent*	*Ounce per ton*	*Ounces per ton*
1918	321, 104, 000	2. 17	0. 0059	2. 03
1919	169, 051, 000	2. 16	. 0071	2. 69
1920	176, 399, 000	1. 76	. 0062	2. 11
1921	47, 958, 000	2. 10	. 0119	4. 37
1922	165, 374, 000	2. 06	. 0065	2. 59
1923	223, 043, 000	2. 12	. 0057	2. 25

Copper, gold, and silver produced by Anaconda Copper Mining Co., from company ores, 1918–1923

Year	Ore treated	Copper	Silver	Gold	Dividends
	Short tons	*Pounds*	*Ounces*	*Ounces*	
1918	4,350,446	272,923,031	10,076,748	64,318	
1919	1,794,358	129,781,031	6,744,262	42,526	$9,325,000
1920	1,828,380	138,763,065	6,420,026	32,530	6,993,750
1921	395,239	32,267,345	2,137,062	8,619	
1922	1,878,162	141,741,235	6,755,212	25,720	
1923	2,735,534	200,779,688	8,568,607	29,726	9,000,000

The annual report of the Anaconda Copper Mining Co. for 1923 states that

The mines of the company produced during the year 2,814,833.20 tons of ore; 8,727.95 tons of precipitates were produced. At the concentrator there were treated 2,892,070.75 tons of ore, 24,113.85 tons of slimes from the ponds, 1,147,570.59 tons of copper tailings, and 60,955.50 tons of zinc-silver tailings. The Anaconda reduction works treated for all companies 3,110,348.27 tons of ore. Of the total amount, 2,735,534.23 tons of ore were produced by the mines of the company, 345,909.48 tons of ore were either purchased from or treated for other companies, and 28,904.56 tons of material were shipped from the old plants at Anaconda and Butte. There were produced 215,107,226 pounds of fine copper, 9,279,770.34 ounces silver, and 30,063.534 ounces gold. Of this production 200,779,688 pounds of fine copper, 8,568,607.18 ounces silver, and 29,725.994 ounces gold were produced for your company. The refinery at Great Falls produced during the year 205,807,887 pounds of cathodes, of which 184,402,584 pounds were melted into shapes at that point. The Raritan Copper Works, at Perth Amboy, N. J., refined 398,294,865 pounds fine copper, 20,643,095.12 ounces silver, and 98,913.51 ounces gold. The mill at Great Falls rolled into rods 110,058,062 pounds of copper; 42,861,964 pounds of rods were drawn into wire, of which 12,083,317 pounds were made into strand.

The largest volume of business in the company's history is reported, but the low price of copper that prevailed during the later part of the year made it impossible to realize profits commensurate with the business done. The net profits for the year, after deducting all fixed charges and depreciation and absorbing discount on bonds retired, amounted to $8,767,814.20. Four dividends of 75 cents a share, amounting to $9,000,000, were declared during the year. The litigation between the Anaconda Copper Mining Co. and the Davis-Daly Copper Co. over the ownership of certain valuable ore bodies has resulted in the purchase of the Davis-Daly properties by the Anaconda Co. during the early part of 1924. In addition to the pure copper shingles manufactured by the company, a new copper-clad shingle has been developed to meet the requirements of moderate-priced dwellings. These shingles have passed the tests of the Board of Fire Underwriters and have been awarded a class A fire rating. A plant for quantity production is under construction.

Development of the copper ore body of the Butte & Superior Mining Co. was continued as operating conditions permitted, and it is estimated that the reserves at the end of the year were approximately 250,000 tons averaging 4.3 per cent of copper and 6.37 ounces of silver to the ton. The company believes that much larger reserves will be proved with continued development.

The East Butte Copper Mining Co. operated during 1923 with a total loss of $93,120.46, as compared with a loss of $134,343.21 in 1922. The company attributes the loss to the inefficiency of labor

and depressed market conditions. Development work carried on during the year is estimated to have disclosed 140,000 tons of ore, compared with 95,000 tons mined during the year.

Operations of East Butte Copper Mining Co., for 1923

Ore mined (wet weight), Pittsmont---short tons--		94, 669
Average assay value, copper----------per cent--		3. 25
Average assay value, silver----------ounces--		4. 40
Cost of mining per ton, including development----		$7. 25
Company ore treated (dry weight)----short tons--		91, 428
Customs ore treated (dry weight)---------do----		131, 958
Total ore treated----------do----		223, 386
Copper produced, Pittsmont smelter----pounds--		13, 674, 932
Silver produced, Pittsmont smelter------ounces--		776, 705
Gold produced, Pittsmont smelter---------do----		692
Gold produced, Swissmont property-------do----		6, 109
Gross value of metals shipped----------		$2, 799, 655. 73
Other income----------		28, 987. 46
Gross income from operations----------		2, 828, 643. 19
Total cost of copper delivered New York----------	$2, 881, 112. 67	
Cost of miscellaneous operations--	9, 196. 17	
Total cost of operations----------		2, 890, 308. 84
Loss on mining operations----------		61, 665. 65
Depreciation----------		1, 646. 49
Outside exploration----------		29, 808. 32
Deficit from all operations----------		93, 120. 46
Copper produced----------pounds--		13, 674, 932
Price per pound received, New York------cents--		14. 4017
Cost of production per pound delivered, New York----------do----		15. 0030
Loss per pound----------do----		. 6013
Average price per ounce received for silver New York----------do----		92. 9376
Price per ounce received for gold, New York------		20. 00

The North Butte Mining Co. operated its mines for only the first six months of the year, owing to the low price of both copper and silver. The company states that the equipment at the mines is sufficient to resume operations as soon as conditions warrant it. The United Metals Sales Corporation sold for this company 12,643,297 pounds of copper at an average price of 14.9594 cents a pound and 466,201.13 ounces of silver at an average price of 95.628 cents an ounce.

Copper, silver, and gold produced by North Butte Mining Co., 1918–1923

Year	Copper ore and precipitates treated	Copper	Silver	Gold	Dividends
	Short tons	*Pounds*	*Ounces*	*Ounces*	
1918	453,356	20,680,695	891,157	1,375	$430,000
1919	287,800	14,331,254	633,215	914	
1920	315,233	16,666,819	693,633	1,004	
1921	24,755	1,229,600	34,536	78	
1922	172,749	9,504,389	308,681	568	
1923	157,871	7,891,177	298,548	545	

NEVADA

In 1923 Nevada joined the group of States that have produced over 1,000,000,000 pounds of copper since the beginning of operations, her production for 1845–1923 being 1,041,402,973 pounds, which represents 3.21 per cent of the total for the country and gives Nevada fifth rank among the copper-producing States. In 1923 Nevada produced 63,495,928 pounds of copper, or 4.42 per cent of the country's total, compared with 20,398,611 pounds in 1922, which was 2.15 per cent of the total. Nevada ranked sixth in production for 1923.

Ely district.—The Ely district of Nevada is one of the large copper-producing districts of the country. At the end of 1923 the total production of the district was 915,209,000 pounds, which gave it eighth rank among the copper-producing districts of the country, and it will undoubtedly maintain its place as the eighth copper-producing district of the country with regard to total production since 1845. The production for several years ending with 1923 is shown below.

Production of metals in Ely (Robinson) district, Nev., 1917–1923

[Mine figures]

Year	Ore	Copper produced	Average yield in copper	Gold and silver, per ton of ore
	Short tons	*Pounds*	*Per cent*	*Cents*
1917	4,466,017	[a]93,615,355	1.05	18
1918	4,519,445	[a]92,396,638	1.02	24
1919	2,273,961	47,871,048	1.05	17
1920	2,589,546	48,347,828	.93	21
1921	400,810	10,282,527	1.28	25
1922	630,871	22,614,736	1.79	19
1923	2,833,674	65,928,279	1.16	21

[a] Smelter production.

The production of the Nevada Consolidated Copper Co. increased quarterly as units of the concentrating plant were completed and put into operation. At the end of the year 19 fine-grinding ball mills, having a capacity of approximately 9,500 tons daily, had been put into operation, and there still remained 7 mills to be installed. It was thought that all 26 would be ready for use late in the summer of 1924. The complete plant, constructed because the old mill was destroyed by fire in 1922, will have a capacity of 13,000 tons a day. The company believes that minor changes in the flow sheet and slight improvements in metallurgical details will insure a recovery of 85 per cent for the concentrator. The average recovery for 1923 was

82.9 per cent. It is reported that incidental explorations during the year indicated considerable commercial ore in extensions of the present porphyry deposits, though this ore can not properly be added to the reserves until its volume and character have been more thoroughly determined. The reserves reported have therefore been obtained by subtracting the quantity mined during the year from ore reserves reported available at the end of 1922. The operating cost of producing copper by the company, including depreciation of plant and equipment, all taxes, and general and other overhead expenses and after applying credits for gold and silver and miscellaneous earnings, was 10.92 cents a pound, compared with 12.4 cents in 1922. The company expects further reductions in cost in 1924. The net earnings for the year, after book entries covering depreciation were deducted, were $2,094,676.82, approximately $1.05 a share of stock, but the company made no distributions to stockholders during the year, in order to maintain a strong position with respect to working capital. The total dividends and capital distributions to stockholders to December 31, 1923, were $46,768,616.60.

Metals produced by Nevada Consolidated Copper Co., 1918–1923

Year	Ore treated	Average assay of copper	Average extraction of copper	Refined copper produced	Dividends
	Short tons	*Per cent*	*Per cent*	*Pounds*	
1918	3,999,526	1.506	67.28	76,607,062	$6,498,235
1919	2,135,425	1.599	70.49	43,971,892	2,999,186
1920	2,568,588	1.449	70.20	48,311,985	1,499,593
1921	392,645	1.49	75.23	9,362,325	
1922	518,523	1.60	75.19	23,762,675	
1923	2,576,388	1.31	82.90	61,573,246	

Ore reserves of Nevada Consolidated Copper Co., December 31, 1923

	Pits		Ruth ore body				Total	
			Porphyry		Sedimentary rock			
	Tons	Per cent	Tons	Per cent	Tons	Per cent	Tons	Per cent
Ore remaining Dec. 31, 1922	51,998,661	1.420	10,891,164	2.342	370,266	7.310	63,260,091	1.613
Mined in 1923	2,057,249	1.204	445,172	1.713	77,010	6.793	2,579,431	1.459
Ore remaining Dec. 31, 1923	49,941,412	1.429	10,445,992	2.368	293,256	7.446	60,680,660	1.620

The Consolidated Coppermines Corporation produced 2,757,723 pounds of copper, 7,338.35 ounces of silver, and 1,154.025 ounces of gold, according to net smelter returns. The additional minable ore proved by this corporation in the different areas January 1, 1924, is stated in the following table:

Ore reserves of Consolidated Coppermines Corporation January 1, 1924

	Short tons	Per cent of copper
Richard sulphide	130,000	5.00
Richard oxide	375,800	3.58
Minnesota	16,700	4.00
Morris-Brooks	420,000	1.50

The company reports that "drilling in the Liberty pit region has indicated an additional 1,250,000 tons of porphyry ore in our claims adjoining the pit to the west and also an extension of the ore body into our claims to the east under the rhyolite. This will be definitely proven by offset holes."

Yerington district.—The Mason Valley Mines Co. did no mining in 1923 but purchased the property of the Bluestone Mining & Smelting Co., which is claimed to contain an indicated ore reserve of over twice that in the Mason Valley mine and to be ready for immediate production. The company acquired with the Bluestone mine a 700-ton concentrator.

NEW MEXICO

Including 1923 New Mexico has made a total production of copper since 1845 of 802,851,895 pounds, which represents 2.47 per cent of the total for the country and gives New Mexico eighth rank among the copper-producing States in total production. In 1923 New Mexico produced 57,521,171 pounds of blister copper, which was 4.01 per cent of the total for the country and placed New Mexico in seventh rank for that year. The Santa Rita district is by far the largest copper-producing district in the State.

Santa Rita district.—The production of copper in the Santa Rita district through 1923 has been 709,566,000 pounds. Figures for 1923 do not change the Santa Rita district's rank as the ninth copper-producing district in total production for the country since 1845. Figures for several years through 1923 are given below.

Copper produced in Santa Rita district, N. Mex., 1917–1923, in pounds

1917	82,200,000	1921	9,138,000
1918	77,547,000	1922	28,408,000
1919	40,359,000	1923	54,375,000
1920	44,400,000		

On February 15, 1924, the Ray Consolidated Copper Co. took over the properties and assets of the Chino Copper Co. The total quantity of ore milled by the Chino mines during the year was 2,785,564 tons, which, together with 11,223 tons shipped direct to the smelter, produced 54,261,228 pounds of marketable copper. The total net production of copper since the beginning of operations at this property, from 26,125,718 tons of ore shipped to the mill and 38,767 tons shipped direct to the smelter, was 602,118,603 pounds. By deducting the ore milled and smelted during the year from the reserves reported at the end of 1922, the reserves at the

end of 1923 are found to be 101,163,114 tons. In order to bring the mill up to date in metallurgical practice for the kind of ore produced from the Chino mines, it was necessary to reconstruct and reequip the entire concentrating department of the Hurley mill and make extensive alterations and replacements in other departments. In spite of delays in the receipt of materials, four of the seven mill sections were put into fairly economical working order by the end of the year, affording satisfactory concentrating facilities for the treatment of about 8,000 tons a day. It is reported that these improvements caused an increase of practically 20 per cent in mill recoveries during the last quarter of the year as compared with those for the first three quarters. No dividends were paid during the year, but since the beginning of operations cash distributions and dividends paid to Chino stockholders have amounted to $29,991,709.50.

Metals produced by Chino Copper Co., N. Mex., 1918–1923

Year	Ore milled (short tons)	Copper content (per cent)	Mill recovery (per cent)	Refined copper produced (pounds)	Gold, silver, and miscellaneous income (cents per pound)	Dividends
1918	3,836,400	1.63	63.275	75,655,641	10.9	[a] $3,914,910
1919	1,765,200	1.82	65.67	40,488,706	21.6	[b] 2,609,940
1920	1,838,140	1.76	70.67	44,051,849	57	[c] 978,728
1921	361,660	1.70	77.36	9,137,282	57	----------
1922	1,416,869	1.55	66.99	28,406,314	90	----------
1923	2,785,564	1.56	66.34	54,261,228	37	----------

[a] $1,087,475 represents distribution of capital.
[b] Total represents distribution of capital; no dividends paid during 1919.
[c] $652,485 represents distribution of capital.

The average operating cost per net pound of copper produced for the period, exclusive of charges for depreciation and after crediting value of precious metals and miscellaneous income, was 12.9 cents, as compared with 11.2 cents in 1922.

Burro Mountain district.—The Burro Mountain branch of the Phelps Dodge Corporation remained closed during the year, but the profit made on copper obtained by leaching the waste dumps at the mines succeeded in paying all expenses, including taxes and pumping. The output from this source was 2,263,287 pounds of copper.

Lordsburg district.—The Eighty-five branch of the Calumet & Arizona Mining Co. produced 94,594 wet tons of ore in 1923. A new sorting plant is claimed to permit shipping a higher-grade ore at a cost for sorting approximately half the cost under the old sorting plant.

The production of the Lordsburg district for several years ending with 1923 is shown below.

Copper produced in Lordsburg district, N. Mex., 1917–1923, in pounds

[Mine figures]

1917	4,262,000	1921	579,000
1918	2,215,000	1922	3,217,000
1919	3,516,000	1923	4,314,000
1920	2,696,000		

TENNESSEE

Inclusive of 1923 Tennessee has made a total smelter production since the beginning of operations of approximately 431,501,000 pounds of copper. Tennessee thus stands as the ninth copper-producing State in the country, with a production of approximately 1.33 per cent of the total. A production of 18,721,932 pounds of copper in 1923 gave Tennessee ninth rank for the year, with 1.30 per cent of the country's total production. The entire output has come from the Ducktown district, in the extreme southeastern part of the State, in Polk County.

Copper produced in Ducktown district, Tenn., 1918–1923

Year	Copper ore treated	Copper produced (smelter)	Average yield of copper	Gold and silver per ton of ore
	Short tons	*Pounds*	*Per cent*	*Cents*
1918	529,012	15,053,568	1.42	18
1919	555,018	15,629,454	1.41	21
1920	589,853	16,727,803	1.42	21
1921	564,457	15,084,294	1.34	18
1922	557,750	14,226,232	1.28	15
1923	776,477	18,721,932	1.21	12

The Burra Burra and London mines of the Tennessee Copper Co. were operated throughout the year, and 457,087 tons of ore was mined. It is estimated that at the end of the year ore reserves for all mines except the Eureka aggregated 3,686,062 tons, of which 72,700 tons had been broken in stopes. The results at the flotation plant during the first part of the year were irregular. A second rod mill was installed in May, and mechanical difficulties were overcome, so that during the second half of the year the operations became steadier and showed improvement in both metallurgy and costs. At the smelter the new Pierce-Smith converter was put into operation on February 1.

Results at flotation plant of Tennessee Copper Co., in 1923

Ore milled	short tons	116,728
Average heads assay	per cent	1.49
Concentrate produced	short tons	11,393
Average concentrate assay	per cent	12.97
Ratio of concentration		10.25:1
Actual recovery	per cent	84.9
Cost per ton of ore	cents	97.694

During the year 484,324 tons of ore was treated, which yielded 12,013,988 pounds of fine copper, an extraction of 24.8057 pounds per ton, at a total cost per ton of ore of $3.38782. The cost of fine copper at the converter was 13.49 cents a pound, as shown on the following page:

Cost of fine copper produced by Tennessee Copper Co., 1923, in cents a pound

Mining expense	5.289
Railway expense	.239
Smelting and milling expense	5.418
Converter expense	1.106
General expense	1.301
Improvement accounts charged direct to copper	.137
Total operating cost (exclusive of New York charges)	13.490

The cost of fine copper in pig, including freight, commission, taxes, legal and administration expenses, and other charges, was 15.3 cents a pound. Three dividends of 25 cents a share were paid during the year, and a fourth was declared to stockholders of record at the close of business December 31, 1923, payable January 15, 1924.

Copper and sulphuric acid produced by Tennessee Copper Co., 1918–1923

Year	Ore smelted	Copper	Sulphuric acid, 60° Baumé	Dividends
	Short tons	*Pounds*	*Short tons*	
1918	402,071	9,819,838	283,092	$392,817
1919	413,877	10,414,815	266,627	----------
1920	404,000	10,358,237	333,629	----------
1921	302,584	8,018,577	242,743	----------
1922	287,499	7,553,281	218,676	----------
1923	484,324	12,013,988	299,231	(a)

[a] Three quarterly dividends of 25 cents a share.

The Ducktown Sulphur, Copper & Iron Co. operated throughout the year. This company and the Tennessee Copper Co. are the only copper producers in Tennessee.

UTAH

Utah has made the fourth largest copper production of the country from 1845 through 1923, having produced 2,698,346,815 pounds, or 8.30 per cent of the total of 32,492,941,479 pounds for the United States. In 1923 Utah ranked third, having displaced Michigan, with a production of 210,118,291 pounds of copper, or 14.64 per cent of the total for the country, compared with 79,665,563 pounds, or 8.38 per cent of the total, in 1922.

Bingham district.—The total production of the Bingham district through 1923 has been 2,372,890,000 pounds of copper, or 7.30 per cent of the total for the country, which gives the district fourth rank in total production since 1845. The production for this district for several years ending with 1923 is shown below.

Copper produced in Bingham district, Utah, 1917–1923, in pounds

[Mine figures]

1917	225,412,000	1921	28,011,000
1918	211,195,000	1922	91,762,000
1919	116,697,000	1923	216,037,000
1920	110,670,000		

The Utah Copper Co. is by far the largest producer in the district and in the State. By the end of 1923 the Kennecott Copper Corporation had acquired 76.65 per cent of the outstanding capital stock of this company. The net earnings of the company, including miscellaneous income, after deducting depreciation of plants and equipment and other charges, amounted to $10,472,798.69 for the year, corresponding to $6.45 a share of outstanding stock. The cost of producing copper, exclusive of depletion but including charges for depreciation, all fixed and general overhead expenses, and credits for values of precious metals and miscellaneous earnings pertaining to operations, was 8.74 cents a pound in 1923, compared with 8.71 cents in 1922. During the year 11,167,800 tons of concentrating ore was mined, which leaves of the reserves previously reported 347,378,049 tons, averaging approximately 1.35 per cent of copper. The company reports that the churn-drilling campaign of the last two years has proved the existence of a large quantity of commercial concentrating ore, but until this area has been more thoroughly prospected its tonnage will not be calculated for addition to the fully developed reserves. The 2,517,025 cubic yards of overburden removed during the year made a total of 57,018,043 cubic yards. At the Arthur plant 6,508,900 tons of ore, an average of 17,833 tons a day, and at the Magna plant 4,658,900 tons, an average of 12,764 tons a day, a total of 11,167,800 tons, equivalent to a daily average of 30,597 tons, was milled in 1923. For best metallurgical results the Arthur mill is rated at 16,000 tons a day, and when the improvements at the Magna mill are completed the aim will be not to exceed this rate. In January, 1923, the reconstruction of the Magna plant had progressed so far that it was treating a daily average of 4,200 tons of ore, and the improvements installed during the year brought its capacity up to 17,250 tons a day for December. Upon completion this plant will have a capacity of 24,000 tons a day, which with the 16,000 tons a day for the Arthur plant makes a nominal economic mill capacity for the company of 40,000 tons a day. Four quarterly distributions to stockholders, aggregating $6,497,960, were made during the year, at the rate of $4 a share a year. The total distributions to stockholders up to December 31, 1923, have been $125,317,827.50.

Metals produced by Utah Copper Co., from ore milled, 1918–1923

Year	Ore milled	Copper content	Mill recovery	Copper [a]	Gold and silver per pound of copper	Dividends (includes capital distribution)
	Short tons	*Per cent*	*Per cent*	*Pounds*	*Cents*	
1918	12,160,700	1.226	65.11	188,092,405	0.79	$16,244,900
1919	5,538,700	1.26	78.46	105,088,740	.83	9,746,940
1920	5,556,800	1.16	81.38	101,897,758	.81	9,746,940
1921	1,220,700	1.16	83.87	24,511,593	[b] 1.15	4,061,225
1922	4,364,251	1.26	80.00	84,777,712	[b] 1.45	3,248,980
1923	11,167,800	1.12	80.96	195,142,919	[b] 1.313	6,497,960

[a] Net production of refined copper, not copper content of concentrates.
[b] Includes miscellaneous income. Comparative figure for 1920 is 2.09 cents.

Cost of mining, milling, and concentrating copper ore by Utah Copper Co., 1918–1923

Year	Ore (short tons)	Cost per ton			
		Mining	Transportation	Milling	Total
1918	12,160,700	$0.5370	$0.2983	$0.9277	$1.7630
1919	5,538,700	.4900	.3040	1.2062	2.0002
1920	5,556,800	.4823	.2591	1.2472	1.9886
1921	1,220,700	.4998	.1921	1.1679	1.8598
1922	4,364,251	.3833	.1612	.8417	1.3862
1923	11,167,800	.3488	.1088	.6116	1.0692

The litigation between the Utah Consolidated Mining Co. and the Utah-Apex Mining Co. involving apex rights was decided favorably to the latter company.

In 1923 the Ohio Copper Co., which had remained closed throughout 1919, 1920, 1921, and most of 1922, produced 3,819,417 pounds of copper, at a reported cost of 6.82 cents a pound and a reported profit of 6.915 cents a pound. This was made possible through the successful introduction by Samuel K. Kellock and Fred E. Turner, manager and superintendent, respectively, of a system of leaching caved ore in place. This operation is described by Wormser.[1] In outline it is as follows: The block of caved ground in the mine is about 800 feet long, 900 feet wide, and 900 feet deep along the dip. Through this are several raises, formerly used for drawing ore to the Mascotte tunnel level, which are excellent passageways for the solutions that now leach the caved mine workings. Ordinary untreated creek and mine-drainage water is poured over the surface of the caved part of the mine, allowed to percolate through the workings, and caught in a series of precipitation boxes placed close to the raises. The new pumping plant consists of a series of four Allis-Chalmers acid-resisting electrically driven centrifugal pumps with a capacity of 1,500 gallons a minute, on the 100, 400, 750, and Mascotte tunnel levels. Aerating the water by allowing it to cascade over the surface before it percolates through the mine workings causes the solutions to become better leaching agents, owing to the increase of the dissolved oxygen in the water. Loosely baled detinned scrap iron is the precipitation medium. The company reports that engineers who have examined the property state that the present caved area should last for at least 20 years. The management believes that there is an area of mineralized ground east of the present caved ore body that should yield to similar operations a still larger tonnage of ore. The high-grade cement copper produced by this company is shipped to the Garfield smelter at present, but experiments have been made with a view to producing casting copper. A sample of the casting copper contained 99.615 per cent of copper, including silver.

Owing to the constantly depressed market, there was a gradual curtailment of production and development by the Montana-Bingham Consolidated Mining Co. The operations of this company for several years are shown in the following table:

[1] Wormser, F. E, Eng. and Min. Jour.-Press, vol. 116, No. 16, pp. 665–670, 1923; vol. 118, No. 4, pp. 124–127, 1924.

Metals produced by the Montana-Bingham Consolidated Mining Co., 1919–1923

Year	Ore produced (wet)	Metal contents				Smelter returns
		Gold	Silver	Copper	Lead	
	Short tons	*Ounces*	*Ounces*	*Pounds*	*Pounds*	
1919	3,855.38	205.598	14,114	505,906	53,201	$76,065.93
1920	4,660.55	348.606	12,663	750,210	16,278	79,382.77
1921	24,525.68	1,354.941	42,869	1,581,857	21,402	140,188.82
1922	20,936.76	1,027.311	33,014	1,088,711	44,932	105,422.76
1923	10,084.48	639.488	15,183	568,287	15,817	60,925.1

The operations of the Dalton and Lark mines of the Bingham Mines Co. for 1923 are shown below.

Copper, lead, gold, and silver produced by the Bingham Mines Co., from the Dalton and Lark mines in 1923

	Ore		Copper	Lead	Gold	Silver
	Wet tons	*Dry tons*	*Pounds*	*Pounds*	*Ounces*	*Ounces*
Lead ore	4,373.71	4,156.627	142,555	1,644,152	83.948	36,698.20
Copper ore	12,473.87	11,914.398	248,004		715.154	46,286.73
Dry ore	2,194.80	2,006.296	3,852	13,644	354.668	29,392.40
	19,042.38	18,077.321	394,411	1,657,796	1,153.770	112,377.33

Tintic district.—The production of the Tintic district for several years ending with 1923 is shown below.

Copper produced in Tintic district, Utah, 1917–1923, in pounds

[Mine figures]

1917	9,118,000	1921	1,570,000
1918	6,569,000	1922	2,295,000
1919	3,251,000	1923	3,033,000
1920	3,003,000		

REFINERY PRODUCTION

The refinery output of copper in the United States in 1923 was made by 11 plants, 8 of which employed the electrolytic method and 3 employed the furnace process on Lake Superior copper. The Calumet & Hecla Co. usually employs both methods, but the electrolytic plant has not been in commission since December, 1922, as the silver content of the copper is not enough to pay for its recovery.

Six of the large electrolytic refineries are on the Atlantic tidewater, and the three Lake refineries are on the Great Lakes; only two plants are located west of the Great Lakes—one at Great Falls, Mont., and one at Tacoma, Wash. In addition to these refineries there are numerous plants in different parts of the country that make a considerable output from old copper, brass, and other alloys of copper. The output of the regular refining plants is in the form of casting, Lake, and electrolytic copper.

Refinery production from ores of domestic and foreign origin is shown in the table on page 227. The domestic figure is the one which is to be compared with smelter production from domestic

sources, the main difference being the time factor explained in the introduction to this report, by which the figures for refinery production include copper that was mined some three months earlier than the beginning of the calendar year and smelted probably one or two months earlier.

CASTING AND PIG COPPER

Blister copper that is low in precious metals and sufficiently free from impurities for certain uses is refined by the furnace process and ordinarily cast into ingots. This copper is usually unfit for uses requiring a high-grade copper, such as electric transmission, brass manufacture, and rolling, but is suitable for copper castings, and a large part of it is put to that use. Lake copper excepted, a comparatively small percentage of the copper output carries so small a content of precious metals that, together with the added value of electrolytic copper, it will not more than pay for the electrolytic refining of the copper; consequently the output of casting copper is small. Some blister or pig copper low in precious metals has been exported without further treatment and is probably consumed without electrolytic refining. A large percentage of the pig and casting copper shown in the table is from Arizona. Some of the districts produced a rather high grade of blister copper carrying a small amount of precious metals, and it is found profitable to market some of this copper without electrolytic refining. During 1923 the production of furnace-refined new casting copper amounted to 24,019,197 pounds. No unrefined pig and best select copper was reported as produced in 1923.

LAKE COPPER

By Lake copper, as the term is used in this report, is meant the output of the Lake smelters. A considerable portion of this output is refined electrolytically, but most of the electrolytically refined Lake copper is mixed with furnace-refined copper or is sold as some brand of Lake copper. Of the 137,691,306 pounds of copper produced by the Lake smelters in 1923, 6,708,342 pounds was refined electrolytically, either to free the copper from impurities or to recover the silver content.

ELECTROLYTIC COPPER

In the table under the next heading all new copper that was refined electrolytically, except that from the Lake district that was sold as Lake copper, is included under electrolytic copper. In 1923 the production of electrolytic copper from primary materials of domestic origin amounted to approximately 1,302,454,000 pounds and from materials of foreign origin to 509,874,000 pounds, and in addition 85,297,000 pounds was produced from secondary sources—a total electrolytic production of 1,897,625,000 pounds for the year, compared with 1,316,522,000 pounds for 1922.

REFINED COPPER

The total output of new refined copper in 1923 was 1,980,000,000 pounds, an increase of 724,000,000 pounds over that in 1922. Adding to the new refined copper produced from domestic and foreign

sources the imports of refined copper gives the new copper made available for consumption during the year. In this table is shown also the production of secondary copper by the regular refineries, but not the output of plants that treat only secondary material, which is shown in another table.

Primary and secondary copper produced by regular refining plants in the United States and imported in 1918–1923, in pounds

	1918	1919	1920	1921	1922	1923
Primary:						
Domestic [a]—						
Electrolytic	1,560,327,422	1,233,994,324	1,010,240,867	506,532,984	766,944,836	1,302,454,492
Lake	231,096,158	177,594,135	153,483,952	100,918,001	122,545,126	137,691,306
Casting	15,284,635	18,223,145	13,905,114	1,740,393	15,180,723	24,019,197
Pig and best select	76,165,976	3,674,191	4,793,307	222,878	----------	----------
	1,882,874,191	1,433,485,795	1,182,423,240	609,414,256	904,670,685	1,464,164,995
Foreign [a]—						
Electrolytic	454,093,595	335,420,019	341,451,660	336,088,209	345,641,677	509,873,512
Casting and best select	57,329,735	1,262,227	2,290,446	5,275,350	5,203,597	5,797,109
Refinery production new copper	2,394,297,521	1,770,168,041	1,526,165,346	950,777,815	1,255,515,959	1,979,835,616
Imports refined copper	38,087,769	35,138,760	108,743,298	69,249,281	103,143,142	[b] 160,711,227
Total new refined copper made available	2,432,385,290	1,805,306,801	1,634,908,644	1,020,027,096	1,358,659,101	2,140,546,843
Secondary:						
Electrolytic	34,674,062	32,408,548	32,856,549	82,017,382	100,792,685	85,297,052
Casting	9,018,049	38,876,481	49,130,510	24,467,951	45,217,857	46,141,409
	43,692,111	71,285,029	81,987,059	106,485,333	146,010,542	131,438,461
Grand total	2,476,077,401	1,876,591,830	1,716,895,703	1,126,512,429	1,504,669,643	2,271,985,304

[a] The separation of refined copper into metal of domestic and foreign origin is only approximate, as an accurate separation at this stage of manufacture is not possible.

[b] The figures of imports of refined copper from Chile reported by the Chile Exploration Co. have been included in place of the figures of the Bureau of Foreign and Domestic Commerce for Chile, which undoubtedly are very low.

If the output of plants treating only secondary material is added to the production of the regular refining companies, the contribution from plants in the United States to the world's supply of copper for 1923 is found to be 2,802,000,000 pounds.

SECONDARY COPPER

Under secondary copper is considered material recovered from remelting old copper, copper scraps, and copper recovered from the treatment of copper alloys or alloys that are treated without the separation of the copper. A canvass of plants producing secondary copper has been made by J. P. Dunlop, of the United States Geological Survey, and the following figures are taken from his report:

Secondary copper recovered in 1923, with imports and exports of scrap brass and copper, in short tons

Copper as metal	141,300
Copper in alloys other than brass	51,900
	193,200

From new scrap (not including brass)	35,000
From old scrap (not including brass)	158,200
	193,200
Brass scrap melted:	
New clean scrap	150,000
Old scrap	161,000
	311,000
Copper content of brass scrap (averaging about 70 per cent copper):	
New scrap	105,000
Old scrap	112,700
	217,700
Total copper produced from secondary sources (including copper content of brass scrap):	
From new scrap	140,000
From old scrap	270,900
	410,900
Imports of scrap brass	20,395
Imports of scrap copper	2,743
Exports of scrap brass	6,587
Exports of scrap copper	1,772

In addition to the secondary material treated by the regular refining companies, plants that treated secondary material exclusively produced a total of about 690,362,000 pounds of copper as copper and in brass and other alloys of copper, making a total production of 821,800,000 pounds from secondary sources. Of this total at least 280,000,000 pounds was produced by remelting clean scrap produced in the manufacture of copper and brass articles.

Refined copper from secondary sources produced in the United States, 1917–1923, in pounds

1917	766,800,000	1921	434,600,000
1918	705,340,000	1922	671,800,000
1919	574,380,000	1923	821,800,000
1920	624,920,000		

COPPER SULPHATE

The production of hydrous copper sulphate or bluestone by the copper refineries of the United States in 1923 was 31,354,828 pounds, having a copper content of 7,987,000 pounds, as against 33,402,515 pounds, having a copper content of 8,508,000 pounds, in 1922.

STOCKS

Stocks of copper January 1, 1919–1924, in pounds

Year	Refined copper	Blister and material in process of refining	Year	Refined copper	Blister and material in process of refining
1919	180,000,000	562,600,000	1922	459,000,000	283,000,000
1920	631,000,000	273,000,000	1923	216,000,000	361,000,000
1921	659,000,000	465,000,000	1924	264,000,000	432,000,000

IMPORTS AND EXPORTS[1]

The quantity of copper in unmanufactured form imported into the United States in 1923 was 676,473,338 pounds, compared with 541,013,220 pounds in 1922. Individual reports received from some of the large importers of copper show that some of the data entering into the compilations by the Bureau of Foreign and Domestic Commerce have been wrongly classified. They indicate clearly that the figures for imports of refined copper in 1923 reported by the Bureau of Foreign and Domestic Commerce are many million pounds short, and it is probable that the shortage is made up mainly in refined copper reported as unrefined copper.

Copper imported into the United States in 1922 and 1923 by countries, in pounds

[General imports]

Country	Ore (copper content)	Concentrates (copper content)	Matte and regulus (copper content)	Unrefined black copper and copper in bars, pigs, or other forms	Refined in bars, plates, rods, or other forms	Old and clippings for remanufacture	Composition metal, copper chief value
1922							
United Kingdom	2,396,043	1,737,707	119,575	23,241,088	2,739,701	11,556,767	719,034
France	168,591	5,980	394,277	532,003	3,145,752	4,704,910	
Germany	1,114,096		1,591,619		708,514	277,153	175,662
Spain	7,001,731		70,000	13,916,628			
Canada	2,567,149	696,296	283,703	46,211,714	7,532	3,522,162	2,810
Mexico	675,196	11,488,503	3,020,642	46,015,417	47,326	7,508	
Cuba	9,220,800	16,056,822				683,393	9,111
Bolivia	436,153	643,907	345	884,622	20,312	18,745	31
Chile	44,041,453	2,073,710	142,261	44,215,265	96,433,739	103,784	
Peru	1,013,165	104,646	500,340	81,853,488	19,113	39,113	
Venezuela	901,421		1,236,482			7,974	
Australia	24,408			1,850			
British South Africa	15,700	24,584				30,899	
Portuguese Africa		27,494		44,398,268			
Other countries	1,627,220	48,022	1,368,795	1,308,885	21,153	389,007	203,951
	71,203,126	32,907,671	8,728,039	302,579,228	103,143,142	21,341,415	1,110,599
1923							
United Kingdom	102,398	200,485	46,563	556,959	1,617,790	1,904,531	1,492,817
France	336,978	6,097	33,500	2,813,867	3,786,859	34,026	
Germany	1,299,725		1,473	1,215,413		332,797	89,313
Spain	7,494,217	482,688		4,160,761	2,905,493		
Canada	19,374,037	279,003	2,192,826	42,514,549	1,054,078	1,771,377	373,787
Mexico	2,319,922	34,362,617		82,161,843		65,470	
Cuba	9,735,954	13,666,280	5,060	1,645		737,748	12,105
Bolivia	62			2,151,357	163,229		
Chile	45,044,926	22,982		106,077,067	118,446,874	176,641	2,232,193
Peru	1,182,890	229,795		77,893,297	113,268	13,300	
Venezuela	1,450,886	351,254				220	
Australia	107,246			2,872,973			
British South Africa	9,525	33,174					
Portuguese East Africa	64,908			17,187,927			
Other Portuguese Africa				53,031,418	380,120		
Other countries	1,629,029	306,380	681,427	2,624,208	246	449,239	1,996
	90,152,703	49,940,755	2,960,849	395,263,284	128,467,957	5,485,349	4,202,441

[1] Statistics of imports and exports have been compiled by J. A. Dorsey, of the United States Geological Survey, from records of the Bureau of Foreign and Domestic Commerce.

Copper (in unmanufactured form) imported into the United States, 1918–1923, in pounds

[General imports]

1918	575, 805, 115	1921	350, 472, 611
1919	429, 387, 594	1922	541, 013, 220
1920	485, 670, 691	1923	676, 473, 338

The exports of metallic copper (exclusive of ore, concentrates, and composition metal) from the United States in 1923 amounted to 828,854,827 pounds, compared with 742,755,957 pounds in 1922. The figures for exports of metallic copper in 1923 also exclude unrefined copper, which is negligible and figures for which can not be separated from those for ore and concentrates.

Copper exported from the United States, 1922–23, by kind and destination, in pounds

Destination	Ore, concentrates, matte and regulus (copper content)	Unrefined black copper and copper in bars, pigs, or other forms	Refined, in bars, ingots, or other forms	Composition metal, copper chief value	Old and scrap	Pipes and tubes	Plates and sheets	Wire (except insulated)	Rods	Insulated wire and cable	Other manufactures of copper	Total
1922												
United Kingdom	1,332	56,107	73,528,982	143,252	186,500	16,075	386,973	1,345,867	20,808,602	137,303	1,105,700	97,716,693
Belgium		112,030	41,866,516		11,494		224,075	1,520		1,262	529,458	42,746,355
Denmark			1,019,233				1,170		5,974,411	18,774	2,425	7,016,013
France			135,406,760		67,165			149,413	112,009	36,188	1,276,900	137,048,435
Germany	22,464		190,348,952	550	470,715	123	164,295	128,436	2,133,986		527,829	193,797,350
Italy			53,852,337				564	135,160		35,778	304	54,024,143
Netherlands			30,451,269			5,473	7,582	319,133	773,293	6,094	275,401	31,838,245
Norway			347,809			10,116	110	1,233,726	917,811	229,170	63	2,738,805
Spain			11,373,402	1,100			345	93,738		7,277	16,188	11,492,050
Sweden			20,127,664					99,757	190,548	10,568	1,546	20,430,083
Switzerland			593,972			515		1,000	110,000	279	1,145	706,911
Other Europe			874,798			30	2,797	56,701	65	13,497	637	948,525
Canada	26,006	1,596	3,137,748	27,726	1,458,716	843,657	1,962,731	423,848	20,915,397	638,876	1,453,639	30,889,940
India (British)	735		5,061,526			1,925	2,452,154	407,586	42	114,575	22,433	8,060,976
China			42,379,643	20,800		883	7,667	430,633	116	466,144	21,252	43,327,138
Japan	11,620		38,855,814		590,317	99	832	272,837		763,835	10,511	40,505,865
Other countries	301		3,440,514	28,045	15,955	943,684	1,537,159	6,501,125	252,316	6,096,125	937,137	19,752,361
	62,458	169,733	652,666,939	221,473	2,800,862	1,822,580	6,748,454	11,600,480	52,188,596	8,575,745	6,182,568	743,039,888
1923												
United Kingdom	112,312		148,674,614		146,571	689	937,040	704,526	28,611,629	484,790	736,605	180,408,776
Belgium			54,826,830		36,676			18,340	1,224,170	5,875	4,532	56,116,423
Denmark	440		2,445,787				1,122	2,865	5,816,513	11,572	848	8,279,147
France			183,189,925	24,569				14,030	3,584,982	137,838	590,313	187,541,657
Germany			135,930,884		352,660				302,684	67	764,025	137,350,320
Italy			71,129,684		54,722		600	5,046	112,000	17,069	224,036	71,543,157
Netherlands			16,471,295			5,809	18,040	74,568	649,726	2,655	7,046	17,229,139
Norway			640,415			3,291		9,287	1,230,692	122,878	16,112	2,022,675
Spain			5,796,729			260	527	234,953		84,426	7,931	6,124,826
Sweden			27,531,227					470	67,345	160	10,548	27,609,750
Switzerland			542,251					1,083	716,705		1,160	1,261,199
Other Europe			3,260,789				18	9,274		9,568	5,314	3,284,963
Canada	21,420		19,792,565	36,307	2,632,272	1,331,296	1,266,881	638,943	19,790,054	863,170	991,166	47,364,074
India (British)			1,655,004	30,029		407	987,599	226,276		83,338	32,304	3,014,957
China			31,857,222			28,982	17,293	29,384		233,384	28,950	32,195,215
Japan	205,040		21,022,202	915	282,124	45	4,898	24,093	340	1,043,288	12,643	22,595,588
Other countries			4,612,784	28,143	39,520	1,242,614	1,301,725	7,849,854	586,465	8,581,372	1,129,659	25,372,136
	339,212		729,380,207	119,963	3,544,545	2,613,393	4,535,743	9,842,992	62,693,305	11,681,450	4,563,192	829,314,002

Copper exported from the United States, 1918–1923

Year	Pounds		Total value
	Metallic[a]	Total	
1918	744, 243, 481	747, 689, 580	$195, 840, 637
1919	515, 595, 019	516, 627, 775	117, 417, 055
1920	623, 158, 489	624, 053, 701	127, 468, 606
1921	628, 415, 714	628, 804, 750	85, 351, 928
1922	742, 755, 957	743, 039, 888	103, 874, 007
1923	828, 854, 827	829, 314, 002	129, 219, 975

[a] Exclusive of ore, concentrates, and composition metal, and in 1923 of unrefined copper, figures for which are not separable from those for ore and concentrates.

Copper sulphate (blue vitriol) exported from the United States, 1918–1923

Year	Pounds	Value	Year	Pounds	Value
1918	14, 477, 339	$1, 395, 946	1921	3, 582, 933	$217, 491
1919	9, 140, 673	928, 291	1922	5, 250, 556	256, 432
1920	3, 783, 409	306, 899	1923	2, 290, 905	130, 213

Brass and bronze exported from the United States in 1923

	Pounds	Value
Scrap and old	13, 173, 348	$1, 198, 560
Ingots, bars, rods, plates, and sheets	3, 465, 739	703, 503
Pipes and tubes	2, 561, 164	691, 350
Pipe fittings, valves, faucets, etc	3, 059, 615	1, 756, 650
Builders' hardware of brass or bronze	280, 909	235, 874
Wire of brass or bronze	1, 447, 488	488, 823
Other brass manufactures	5, 138, 101	2, 903, 997
Other bronze manufactures	1, 876, 250	841, 207
	31, 002, 614	8, 819, 964

Unmanufactured brass exported from the United States, 1918–1923

[Ingots, bars, rods, plates, and sheets]

Year	Pounds	Value	Year	Pounds	Value
1918	30, 989, 717	$9, 522, 934	1921	2, 874, 762	$741, 110
1919	7, 770, 671	2, 310, 561	1922	3, 660, 340	635, 449
1920	5, 810, 733	1, 671, 608	1923	3, 465, 739	703, 503

CONSUMPTION

The refined new copper withdrawn from the total year's supply on domestic account in 1923 was 1,300,000,000 pounds; in 1922 it was 897,000,000 pounds. The method employed in determining the quantity of copper retained for consumption is shown in the following table, which does not include stocks of copper held by consumers:

New refined copper withdrawn from total year's supply on domestic account. 1918–1923, in pounds

	1918	1919	1920
Total supply of new copper	2,432,385,290	1,805,306,801	1,634,908,644
Stock at beginning of year	114,000,000	180,000,000	631,000,000
Total available supply	2,546,385,290	1,985,306,801	2,265,908,644
Copper exported [a]	704,715,714	439,835,229	553,070,086
Stock at end of year	180,000,000	631,000,000	659,000,000
	884,715,714	1,070,835,229	1,212,070,086
Withdrawn on domestic account	1,661,669,576	914,471,572	1,053,838,558

	1921	1922	1923
Total supply of new copper	1,020,027,096	1,358,659,101	2,140,546,843
Stock at beginning of year	659,000,000	459,000,000	216,000,000
Total available supply	1,679,027,096	1,817,659,101	2,356,546,843
Copper exported [a]	609,038,352	705,025,268	[b] 792,073,512
Stock at end of year	459,000,000	216,000,000	264,000,000
	1,068,038,352	921,025,268	1,056,073,512
Withdrawn on domestic account	610,988,744	896,633,833	1,300,473,331

[a] Includes unrefined black blister and converter copper (bars, pigs, and other forms) and refined in ingots, bars, rods, or other forms.
[b] Exclusive of small quantity of unrefined black blister for which figures are not separable from those for ore and concentrates.

By adding the 822,000,000 pounds of secondary copper and copper in alloys produced during the year to the 1,300,000,000 pounds of new refined copper withdrawn on domestic account, it is found that a total of about 2,122,000,000 pounds of new and old copper was available for domestic consumption. It will be seen from the method of calculation that the figures represent the quantity of new copper withdrawn from supply on domestic account and not actual domestic consumption, as no account is taken of consumers' stocks, figures for which are not available. Furthermore, much of the copper exported is in manufactured forms; consequently much of the copper bought on domestic account during any year is exported in manufactured forms at a later date. The available figures do not permit an accurate calculation of copper consumption.

USES

There are no data available showing the quantity of copper that entered the different industries, and the great changes due to the war render any estimate more uncertain than usual.

The following table shows the copper cast in different forms in 1923. It will be noted that the total is not the same as the production of refined copper:

Copper cast in different forms in 1923

Form	Pounds	Percentage
Wire bars	1,238,000,000	59.75
Ingots	397,000,000	19.16
Cakes	251,000,000	12.11
Cathodes	98,000,000	4.73
Other forms	88,000,000	4.25
	2,072,000,000	100.00

PRICES

Reports to the United States Geological Survey from copper-selling agencies in the United States indicate that 2,404,768,102 pounds of copper was delivered to purchasers in 1923 at an average price of 14.71 cents a pound, 1,665,592,169 pounds to domestic purchasers, and 739,175,933 pounds to foreign purchasers. In 1922 the agencies reported sales of 1,913,000,000 pounds at an average price of 13.4665 cents.

Price per pound of copper, 1900–1923, in cents [3]

1900	16.6	1906	19.3	1912	16.5	1918	24.7
1901	16.7	1907	20.0	1913	15.5	1919	18.6
1902	12.2	1908	13.2	1914	13.3	1920	18.4
1903	13.7	1909	13.0	1915	17.5	1921	12.9
1904	12.8	1910	12.7	1916	24.6	1922	13.5
1905	15.6	1911	12.5	1917	27.3	1923	14.7

The average price for the last 20 years was 17.8538 cents, compared with 14.7 cents in 1923.

Average monthly prices at New York per pound of electrolytic copper in 1918–1923, in cents, as reported by the American Metal Market Co.

Month	1918	1919	1920	1921	1922	1923
January	23.50	20.05	19.02	12.85	13.60	14.66
February	23.50	16.91	18.61	12.79	12.97	15.50
March	23.50	15.01	18.36	12.23	12.84	16.96
April	23.50	15.40	18.54	12.54	12.71	16.81
May	23.50	16.005	18.28	12.83	13.29	15.63
June	23.50	17.655	17.97	12.76	13.71	14.88
July	25.89	21.71	18.61	12.35	13.90	14.59
August	26.00	22.22	18.44	11.76	13.96	14.05
September	26.00	21.95	18.04	12.105	13.88	13.60
October	26.00	21.505	16.30	12.75	13.80	12.81
November	26.00	19.96	14.39	13.16	13.79	12.89
December	25.285	18.48	13.48	13.67	14.22	12.98
Average	24.68	18.905	17.50	12.65	13.56	14.61

Average monthly quoted prices at New York per pound of electrolytic copper in 1918–1923, in cents, as reported by the Engineering and Mining Journal-Press

Month	1918	1919	1920	1921	1922	1923
January	23.50	(a)	18.918	12.597	13.465	14.510
February	23.50	16.763	18.569	12.556	12.864	15.355
March	23.50	14.856	18.331	11.976	12.567	16.832
April	23.50	15.246	18.660	12.438	12.573	16.663
May	23.50	15.864	18.484	12.742	13.111	15.440
June	23.50	17.610	18.065	12.697	13.575	14.663
July	25.904	21.604	18.576	12.170	13.654	14.321
August	26.00	22.319	18.346	11.634	13.723	13.822
September	26.00	21.755	18.144	11.948	13.748	13.323
October	26.00	21.534	15.934	12.673	13.632	12.574
November	26.00	19.758	14.257	13.035	13.598	12.727
December	(a)	18.295	13.138	13.555	14.074	12.823
Average	24.628	18.691	17.456	12.502	13.382	14.421

[a] No market.

[3] Weed, W. H., Copper Handbook, vol. 11, pp. 1339, 1343, for years 1900–1903. Survey computations for electrolytic copper since 1904. For 1916 and later years average price all marketable grades.

RARE METALS

By Frank L. Hess[1]

COBALT

No cobalt ore is known to have been produced in the United States during 1923, nor were any discoveries of new deposits reported. The known deposits in this country are so small that all supplies must be imported.

In 1923 the value of the cobalt, cobalt ore, cobalt oxide, and other compounds imported into the United States was the largest ever reached and amounted to $1,148,019. Most of our cobalt comes from Canada, which is the largest producer.

Cobalt ore, cobalt, zaffer, and oxide imported for consumption in the United States, 1919–1923

Year	Ore		Cobalt		Zaffer		Oxide		Total	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
1919	17,045	$2,832	60,511	$141,450			131,424	$184,751	208,980	$329,033
1920	13,039	4,794	143,603	326,864	220	$14	202,724	399,605	359,586	731,277
1921	7,657	3,235	38,442	105,539			164,003	342,426	210,102	451,200
1922	5,195	7,075	126,364	321,396			217,530	435,895	[a]349,089	[a]764,366
1923	58,719	56,326	225,639	552,434			258,574	511,903	[a]542,932	[a]1,120,663

[a] Also 11 pounds of "other salts and compounds," valued at $26, imported Sept. 22 to Dec. 31, 1922. Not separately classified prior to new tariff. Similar imports in 1923 were 45,644 pounds, valued at $27,356.

Cobalt compounds imported for consumption in the United States, 1923

	Pounds	Value
Linoleate	3,617	$1,140
Sulphate	39,691	24,597
Other salts	2,336	1,619
	45,644	27,356

Cobalt and cobalt ore imported into the United States in 1923, by countries

Country	Pounds	Value
Australia	38,772	$10,112
Belgium	278	66
Canada	175,189	442,740
England	70,108	155,818
Germany	11	24
	284,358	608,760

[1] The statistics of imports and exports were compiled by J. A. Dorsey, of the United States Geological Survey, from records of the Bureau of Foreign and Domestic Commerce.

MOLYBDENUM

Molybdenum was produced in the United States during 1923 only at Questa, N. Mex., by the Molybdenum Corporation of America, which operated only during November and December. The demand for ores is still light, so that imports were small, but the results obtained through the use of small quantities of molybdenum in some steels are apparently so excellent that persons acquainted with the situation remain confident that much larger markets will be developed.

The production and imports of molybdenum ores during the last few years are shown in the following tables:

Molybdenum in ore and concentrates, produced in the United States, sold in 1917–1923

Year	Pounds	Value	Year	Pounds	Value
1917	350,200	$495,350	1921		
1918	861,637	1,253,700	1922		
1919	297,926	341,814	1923	22,667	(a)
1920	34,900	17,207			

[a] Not reported.

"Molybdenum ore (steel-hardening)" imported for consumption in the United States, 1918–1923

Year	Pounds	Value	Year	Pounds	Value
1918 (July to December [a])	140,222	$123,924	1921	29,783	$20,471
1919	106,743	77,572	1922 [b]	412,221	90,015
1920	15,639	9,707	1923 [b]	16,671	13,115

[a] Not separately classified prior to July, 1918.
[b] Classification under new tariff in effect Sept. 22, 1922, "Molybdenum ore and concentrates (molybdenum content)."

The country of origin of the imported ore is not known.

NICKEL

In 1923, as usual, no nickel ore was produced in the United States, but 199,040 pounds of nickel, contained in 909,430 pounds of nickel sulphate carrying 21 to 22.5 per cent nickel, was obtained as a by-product in the electrolytic refining of copper. The salt was sold for 5.8 to 8.8 cents a pound, and the total value was $71,605. Heretofore part of the salts produced have usually been "double salts" (nickel-ammonium sulphate), and the American Smelting & Refining Co. made its nickel into metal.

Nickel content of nickel salts and metallic nickel produced in the United States as a by-product in the electrolytic refining of copper, 1918–1923, and from mixed ores in 1919 and 1920.

Year	Short tons	Value	Year	Short tons	Value
1918	441	$401,000	1921	111	$86,000
1919 [a]	511	434,485	1922	208	133,191
1920 [a]	365	293,250	1923	100	71,605

[a] Including nickel produced from copper-lead-cobalt-nickel ores mined in Missouri.

Canada is the dominant producer of nickel, and the United States receives much the larger part of its supply from that country. Three companies produce the Canadian nickel. Of these the International Nickel Co. is the largest producer. From its principal mine, the Creighton, near Sudbury, Ontario, it takes ore averaging between 5 and 6 per cent of nickel and copper in the proportion of 2 parts of nickel to 1 part of copper. The ore is smelted to matte at Copper Cliff, Ontario. The matte from which nickel is to be extracted is shipped to Port Colborne, Ontario, and that for Monel metal, an alloy of about 2 parts nickel, 1 part copper, and a little iron, is shipped to Huntington, W. Va.

The Mond Nickel Co. obtains its nickel ore from the Carson mine, 6 miles from its smelter at Coniston; the Levack mine, 35 miles west on the Canadian Pacific Railway; the Worthington mine, 35 miles west on the "Soo" branch of the Canadian Pacific Railway; and the Victoria No. 1 mine, 30 miles west on the Algoma Eastern Railroad. The ore averages about 5 per cent combined nickel and copper, and the matte averages 48 per cent nickel and 35 per cent copper. The matte is shipped to Clydach, Wales, where it is refined by the nickel carbonyl process. The company has a subsidiary, the American Nickel Co., with a plant at Clearfield, Pa., where nickel sheet, rod, wire, seamless and welded tubing, and other products are made. It manufactures Mond metal, an alloy of 70 per cent nickel, 26 to 27 per cent copper, 2 to 3 per cent manganese, and 1 per cent impurities.

The British American Corporation is the youngest of the Canadian companies. It has a smelter at Nickelton, Ontario, and a refinery at Deschenes, Quebec. The ore carries nickel and copper in about the proportion of 20 parts of nickel to 11 parts of copper. The grade of the ore is lower than that of the other two companies.

The change in the use of nickel with the decrease in building of warships has been marked. Sir Alfred Mond, speaking for his own company, the Mond Nickel Co., is reported [2] to have said that

> Previous to the war probably 50 per cent of their nickel had gone to steel makers for armaments and 50 per cent for the production of nonferrous alloys and pure-nickel products, whereas last year [1922–23] only 12½ per cent had gone to the former and 87½ to the latter. That was counteracting the effect of the Washington treaty on the manufacture of armaments. The use of nickel for coinage was increasing, many countries now replacing their paper currency with nickel. The Italian Government, for instance, had recently placed large orders for the supply of pure nickel coinage, this company obtaining the contract for the supply of the raw material. A similar contract had been obtained for one of the Baltic States. They had also supplied considerable quantities of nickel for other nickel and nickel bronze currencies in various parts of the world.

In 1923 the uses estimated by the International Nickel Co. from its orders were 40 per cent in steel, 16 per cent in nickel silver, 26 per cent in anodes, 11 per cent in special alloys, and 7 per cent in miscellaneous uses.

The following information is abstracted from the printed report of the International Nickel Co. for the year ending March 31, 1924:

> The market price of nickel is extremely low, due to the fact that potential supply is still far in excess of present world demand, and this status must continue in the industry until new and increased uses for nickel are found.

[2] Canadian Min. Jour. Oct. 5, 1923, p. 785.

Anticipating this condition, your management built the rolling mill at Huntington, W. Va., and has instituted a policy of active sales exploitation and development which is showing gratifying results.

At the Creighton mine, Ontario, uninterrupted operations and a uniform rate of output enabled your management to maintain low costs. Development has kept pace with an increased smelter demand and this property is in excellent condition.

The smelter at Copper Cliff, Ontario, was in blast throughout the year. Continuity of operations, coupled with cheaper fuel and increased efficiency, enabled your operatives to furnish Bessemer matte to the refineries at less than pre-war cost.

Refinery production at Port Colborne, Ontario, was regulated to sales requirements, the percentage of plant capacity used being sufficient to assure efficient and economical operating conditions. Due to numerous improvements in process and equipment, costs have been materially reduced. This refinery can now produce, in various forms, 24,000 tons of nickel per annum, or an amount approximately equal to total world sales at the present time. * * *

Since the war it has become more and more apparent to metal refiners that the most effective method of extending markets is to provide equipment for producing rolled or fabricated output. The copper, zinc, and aluminum industries have met with notable success by adopting this plan.

For many years prior to the construction of the Huntington mill your company sold a small tonnage of rolled nickel and Monel metal, which was produced under toll arrangements by other companies. The principal business, however, was selling refined nickel to a comparatively small number of consumers who purchased in quantity. Your management was convinced that by constructing a new works to convert refined metal into finished forms pure nickel and nickel alloys could be introduced and sold to a great number of diversified industries and small consumers.

The new rolling mill has been in continuous operation for a period of 20 months and has clearly demonstrated the wisdom of making this large capital investment. As originally designed the Huntington works provided for the production of hot-rolled rods and sheets, for which a market existed. This product is sold for numerous applications where metal of great strength and noncorrosiveness is required.

As a result of sales effort it is now evident that large tonnages of more highly finished products, such as cold-rolled sheets and cold-drawn rods, can be sold at profitable prices, and your management is extending mill facilities to manufacture these new products as rapidly as a permanent market can be developed.

In a comparatively short time nickel and Monel metal have been introduced and are now used in the dye and textile industry; for the construction of laundry machines; for dairy apparatus, pasteurizers, and milk containers; in cafeteria, hotel, and kitchen equipment; in the packing industry for table tops and containers; in dining-car kitchens and Pullman car equipment; for automobile trim; in hospital and surgical apparatus; for handling ice cream and food products; for soda-fountain trim; or in general for metal articles in daily use where strength and sanitary cleanliness, together with an attractive appearance, are desired.

In summarizing it may be stated that there is an increasing demand for an ornamental white metal of high surface finish, possessing the physical properties of nickel and Monel metal, and it is the opinion of your management that the distribution of mill products will eventually constitute a very large portion of the company's sales.

Concerted effort by a competent research, development, and sales organization has demonstrated that nickel may now be classified as a necessary engineering metal rather than an ordnance metal, and this opinion is confirmed by the many new uses and diversified applications of nickel and nickel alloys made during the past year.

Carefully directed publicity through engineering channels, trade publications, and industrial bulletins, together with a limited amount of advertising, is creating a growing volume of business, the major part of which is sales of Huntington mill products.

In conclusion it may be said that while extending the uses of your company's products is of necessity slow the aggressive exploitation now under way will eventually create a large, permanent, and profitable business based on peace-time demand.

"Inco," published quarterly by the International Nickel Co., contains an article (No. 1, vol. 5, p. 13) written by Robert C. Stanley entitled "Twenty years of Monel nickel." "List B," also published by the International Nickel Co., gives brief memoranda of numerous articles descriptive of Monel metal and nickel, their technical and mechanical properties, specific uses, and methods of working.

The United States Nickel Co., at New Brunswick, N. J., imports a rich matte made in Belgium from New Caledonian ore and smelts nickel from it.

The production and exports of nickel metal, nickel-copper matte, etc., from Canada during 1921–1923 are shown below:

Nickel produced in Canada and exported, 1921–1923

	1921		1922		1923	
	Pounds	Value	Pounds	Value	Pounds	Value
Production:						
Nickel contained in matte	19,256,900		17,355,056		62,057,835	
Nickel from Cobalt ores	36,100		242,067		396,008	
	19,293,000	$6,752,571	17,597,123	$6,158,993	62,453,843	$18,332,077
Exports:						
Nickel, fine	4,794,500	1,684,453	14,449,700	4,287,941	22,897,900	4,649,251
Nickel contained in matte	8,064,600	1,418,490	16,768,200	2,536,347	28,971,000	4,077,006
	12,859,100	3,102,943	31,217,900	6,824,288	51,868,900	8,726,251

The nickel imports and exports of the United States have been as follows:

Nickel imported for consumption in the United States, 1918–1923

Year	Nickel, nickel ore and matte, nickel oxide, and alloys of nickel with copper, etc.		Manufactures and nickel sheets and strips	Total value
	Pounds	Value		
1918	73,207,147	$11,520,775	$115,243	$11,636,018
1919	36,562,388	8,334,135	90,451	8,424,586
1920	48,492,076	10,657,193	200,464	10,857,657
1921	4,396,119	1,210,317	107,155	1,317,472
1922	14,919,362	3,945,168	110,176	4,055,344
1923	40,669,203	6,601,995	92,977	6,694,972

Nickel imported for consumption in the United States, 1921–1923, by classes

Class	1921		1922		1923	
	Pounds	Value	Pounds	Value	Pounds	Value
Nickel ore (nickel content)	660,067	$129,053	3,085,632	$396,726	14,601,820	$1,145,645
Nickel matte (nickel content)	1,382,111	303,733				
Nickel alloys, pigs, bars, etc	2,324,993	770,021	11,341,360	3,438,225	23,783,041	5,159,888
Nickel oxide	28,948	7,510	492,370	110,217	2,284,342	296,462
All other manufactures	[a]	107,155	[a]	110,176	127,324	92,977
		1,317,472		4,055,344	40,796,527	6,694,972

[a] Quantity not recorded prior to new tariff. Imports from Sept. 22 to Dec. 31, 1922, were 24,586 pounds, valued at $23,710.

Nickel, nickel oxide, and matte exported from the United States, 1917–1923

Year	Pounds	Value	Year	Pounds	Value
1917	21,992,820	$8,936,620	1921	425,851	$103,372
1918	17,469,500	6,927,041	1922	9,317,520	1,016,091
1919	3,810,656	1,697,544	1923	[a] 11,200	[a] 626
1920	1,215,232	574,845			

[a] Nickel oxide and matte only. Separate figures for nickel not available. See following table.

Beginning with 1922, additional classes of nickel exports were shown. The complete exports for 1922 and 1923 are given in the following table:

Nickel exported from the United States in 1922 and 1923, by classes

Class	1922		1923	
	Pounds	Value	Pounds	Value
Oxide and matte	9,311,680	$1,013,069	11,200	$626
Nickel	5,840	3,022	868,158	307,269
Monel metal and other alloys	913,983	196,702		
Manufactures	249,467	179,094	488,088	290,452
Nickel or German silver in bars, rods, or sheets	402,922	121,755	481,178	145,518

TANTALUM

Tantalum and its close associate, columbium, are yet among the experimental metals—those which possess attractive properties but which have not been shown to have extensive uses that some other and cheaper metal or alloy will not serve as well or better. With the numberless new uses for the elements and their alloys and compounds that constant experimentation is developing, it seems probable that for these metals also places will be found that they will fill better than any others.

To obtain these metals in a pure state, or a state of purity comparable to that of the iron, aluminum, or copper of ordinary commerce, is very difficult and tedious, though not impracticable, as it is with vanadium. However, like vanadium, they can be made into ferroalloys with comparative ease. Several patents for their use in steel have been taken out, but the steels have been made only in experimental lots. So far as is known, the steels made have all contained both tantalum and columbium, and it is therefore not known what the effect of either metal alone would be.

The only known output of ores of these metals made in the United States for several years has been that shipped by Dr. A. T. Roos, Rapid City, S. Dak., who states that the production of columbite in 1923 was 1,350 pounds,[3] valued at $540, and in 1922 was 600 pounds, valued at $240. In 1921 Doctor Roos shipped 3,400 pounds of columbite guaranteed to contain 70 per cent of the combined tantalum and columbium oxides. The material was valued at about $1,150. The columbite came from pegmatite dikes near Keystone and Hill City, in the southern part of the Black Hills. Previous shipments by Doctor Roos have been as follows: 1920, 4,000 pounds, valued at $1,450; 1919, 300 pounds, valued at $90; 1918, 4,500 pounds, valued at $2,250.

[3] Figures are published with the express permission of Doctor Roos.

All the ore is thought to have been used for experimental purposes, most of it in ferro-tantalum-columbium, without separation of the two metals.

No imports of tantalum ores were recorded in 1922. The records of the Bureau of Foreign and Domestic Commerce show that 5,600 pounds of "tantalum steel-hardening ores," valued at $3,031, were imported for consumption in 1923.

American ores are not sufficiently free from columbium to make them suitable for the manufacture of tantalum under present processes.

During the year the Fansteel Products Co., of North Chicago, Ill., placed on the market a charger for storage batteries in which tantalum is used as an electronic valve.

TITANIUM

During 1923 the American Rutile Co. (owned by the Thermit & Metal Corporation, 120 Broadway, New York) operated its quarry at Roseland, Nelson County, Va., a part of the year and produced 270 short tons of rutile concentrates carrying about 95 per cent of titanium dioxide and as a by-product 466 tons of ilmenite concentrates carrying about 52 per cent of titanium dioxide. The production of rutile and ilmenite from this property during the last five years has been as follows:

Rutile and ilmenite produced by American Rutile Co., 1919–1923, in short tons

Year	Rutile	Ilmenite
1919	102	106
1920	277	268
1921	--	--
1922	310	600
1923	270	466

Buckman & Pritchard (Inc.), a subsidiary of the Titanium Pigment Co. (Inc.), with works at Niagara Falls, N. Y., worked the beach sands 4 miles south of Pablo Beach, Fla., in which ilmenite has been concentrated between high and low tide levels. The sand also contains considerable zircon, a little rutile, and a little monazite. During the year 5,804 tons of ilmenite carrying probably about 52 per cent of titanium dioxide was shipped to Niagara Falls to be used for the manufacture of both titanium pigment by the Titanium Pigment Co. (Inc.) and ferrotitanium by the Titanium Alloys Co., an affiliated company. This is an increase of 1,223 tons over the shipments in 1922. The company also shipped 153 tons of zircon during the year.

The use of titanium pigment is growing. The titanium oxide is not used alone but is precipitated with barium or calcium salts or both, so that titanium dioxide forms only about 25 per cent of the mass. Even this is not used alone for most work, because it tends to "chalk." It is therefore mixed with zinc oxide and is thus said to form an excellent pigment. In the manufacture of the pigment it is of course advantageous to start with as pure an ilmenite as possible, because the iron and other impurities must be removed, and

iron is the most troublesome of the impurities, because it wastes chemical reagents and has a high coloring power.

The price of concentrated rutile ranges from 10 to 25 cents a pound, depending on quality, quantity, fineness of grinding, and other factors. The price of ilmenite ranges from $15 to $25 a short ton.

The imports of "titanium-potassium oxalate and all compounds and mixtures containing titanium" in 1923 amounted to 39,763 pounds, valued at $6,423. In 1922, after September 22, when the new tariff became effective, the imports were 82,544 pounds, valued at $20,596. The duty is 30 per cent ad valorem.

The market for rutile, used mostly for arc-light electrodes and for potassium-titanium oxalate to be used in dyeing and in the manufacture of leather, is small, and that for ilmenite, to be used in ferrotitanium, is apparently not growing much, but the use of ilmenite in the manufacture of pigments is increasing and the substitution of titanium oxide pigments for white lead should increase very greatly and tend to conserve the supply of lead for other uses.

TUNGSTEN

In 1923 the first domestic tungsten ore mined in three years was produced by the Wolf Tongue Mining Co. and the Vasco Mining Co. in the Boulder field, near Nederland, in Boulder County, Colo. The two companies produced and shipped an equivalent of 241 short tons of ferberite concentrates carrying 60 per cent of tungsten trioxide, though the ore shipped ranged from 55 to 63 per cent.

William Loach, manager for the Wolf Tongue Mining Co., estimates that tungsten can not be mined in Boulder County at a cost of less than $12 a unit, and this figure probably does not include amortization. There are few if any known deposits in the United States that can be profitably operated even at that price. The duty on tungsten ore ($7.14 a unit) has thus far not stimulated mining but has benefited those holding ores in stock. The Vasco Mining Co. closed its mines and mills and probably will not again open them. Both companies operated because they were largely owned by steel companies that used the ore themselves even though it cost more than the market price.

Chinese ores, as before, dominated the world's markets. The centers of production are reported to have swung southwestward from Kiangsi to northern Kwangtung. It is said that Chinese concentrates can be landed in New York or London at $2.75 or less a long-ton unit.

Ore still reaches England from the Malay Peninsula and Burma. These countries continue to produce considerable quantities of ore because it is obtained mixed with cassiterite, which commanded a fairly good price during 1923, though probably not what would be a normal price if Europe were back to a peace-time business basis.

Owing to the disturbed conditions the European demand for tungsten was poor during 1923, so that the very cheap and good Chinese ore seeking a market, in connection with the large stocks of tungsten ores, ferrotungsten, tungsten powder, scrap alloy steel.

and scale held in the United States, kept prices down to points less than $3 above the duty.

Prices in the United States ranged from $7.50 a unit for Chinese wolframite and $8 for scheelite at the beginning of 1923 to $8.25 to $9, depending on quality, for Chinese wolframite and $10 for scheelite at the end of the year. The price of ferrotungsten carrying 75 to 93 per cent of tungsten ranged from 88 to 92 cents per pound of contained tungsten; some was forced on the market near the end of 1923 at 75 to 80 cents a pound.

Prices in England for wolframite carrying a minimum of 65 per cent of tungsten trioxide were, at the beginning of 1923, nominally 13s. 6d. per long-ton unit (22.4 pounds WO_3) and in December, 12s. Ferrotungsten carrying 80 to 85 per cent of tungsten was quoted at about 1s. 5d. throughout the year, and tungsten powder at 1s. 10d. at the beginning of the year and 1s. 9d. at the end. All these prices would probably have been shaded had there been a prospect of real business.

Never since tungsten became an article of trade have the quantity of tungsten used and the quantity in stock been certainly known, and few among those most familiar with the trade have agreed in their estimates of either quantity. Throughout 1923 estimates were very far apart, and a canvass of the industry was therefore made through circular letters, which were sent to every person and firm known to have tungsten in any form at any time after September 22, 1922, when the new duty went into effect. The inquiries asked for stocks on November 1, 1923, because the first letters were sent out on that date. Some firms, however, did not find it convenient to furnish the figures at once, and for some other reasons the work of assembling the statistics occupied an unexpectedly long time. The response to the rather tedious inquiries was gratifyingly cordial, and very few found it inexpedient to give the data requested.

Although the tungsten used in making incandescent-lamp filaments, contact points, and chemicals has a value that is beyond comparison with equal quantities used in steel making, just as the steel put in hairsprings is not to be compared in unit value with that used in rails, the quantities used for these purposes are so small that they affect the general market very little, so that the market price of tungsten is fixed by its use in steel.

In the following table all items are reduced to their equivalent in short tons (2,000 pounds) of ore carrying 60 per cent of tungsten trioxide. Ore "used" means ore put in a final product, such as tool steel, lamp filaments, or chemicals. Ferrotungsten and tungsten powder are regarded as intermediate products in the preparation of the ore for use. Stocks "on hand" include all items in the hands of producers, investors, and users and in warehouses.

In estimating the quantity of ore represented by a given quantity of tungsten powder or ferrotungsten the tungsten in these products has been multiplied by 2.5 on the supposition that under the average metallurgical practice about 800 pounds of tungsten is recovered from a short ton of ore carrying 60 per cent of tungsten trioxide. Some will probably disagree with this estimate, but, as the factor employed is stated, corrections can be made as desired.

Tungsten on hand when new duty went into effect (September 22, 1922), used between September 22, 1922, and November 1, 1923, and on hand November 1, 1923, in short tons.

[Tungsten in tungsten powder, etc., is expressed in its equivalent in ore carrying 60 per cent WO_3]

On hand September 22, 1922:		
Ore (partly estimated)		13,415
Tungsten powder		454
Ferrotungsten		796
Tungsten in scrap steel		652
Tungsten in scale and chemicals		16
		15,333
NOTE.—The error due to estimates and other uncertainties is believed to be less than 1,000 tons.		
Used between September 22, 1922, and November 1, 1923:		
Ore		2,302
Tungsten powder		1,257
Ferrotungsten		3,471
Tungsten in scrap steel		2,465
Tungsten in scale and chemicals		75
		9,570
Possible overestimates due to resales of tungsten powder and ferrotungsten and to other errors, say	570	
Errors due to returns which included tungsten used after November 1, 1923	300	
		870
		8,700
On hand November 1, 1923:		
Ore		7,087
Tungsten powder		946
Ferrotungsten		1,250
Tungsten in scrap steel		850
Tungsten in scale and acid		26
		10,159

Errors may have been made by counting twice quantities of ore owned by one firm but stored with another, but these errors are doubtless offset by quantities of ore of which no record was obtained.

The quantity of tungsten used in steel (including the small tonnage used in other industries) during the period between September 22, 1922, and November 1, 1923, was probably fully the 8,700 tons indicated, for the allowances made are believed to be ample. Business in tool steel was reported to be poor during the last part of 1923.

The figures indicate a consumption of about 8,000 tons in a year, more than in any other year except the last year of the Great War, and to this quantity should be added an unknown quantity in scale (made in hammering and rolling tungsten steel), for some companies use scale without keeping a record of the quantity used.

The facts that so much tungsten was used and that the high-speed steel business was not brisk during part of the year create the presumption that large stocks of high-speed steel were being carried

at the end of the year, but no figures are known that either prove or disprove this statement. It is known that some firms had very large stocks.

The production of tungsten ore in the United States since 1915 is shown in the table below:

Concentrated tungsten ores (carrying 60 per cent of tungsten trioxide), produced in the United States, sold in 1915–1923, and average price per unit

Year	Short tons	Value	Average price per unit	Year	Short tons	Value	Average price per unit
1915	2,332	$4,100,000	$29.30	1920	216	$101,800	$7.86
1916	5,923	12,074,000	33.98	1921			
1917	6,141	6,783,000	18.40	1922			
1918	5,061	7,049,300	23.24	1923	241	144,600	10.00
1919	327	353,900	18.02				

No tungsten ore was imported into the United States during 1923. The imports for consumption included tungsten and ferrotungsten, tungsten powder, tungstic acid, and other tungsten compounds—tungsten content, 39 short tons, valued at $25,907; also tungsten-nickel and alloys of tungsten, not specially provided for—tungsten content, 49 pounds, valued at $2,258. Of "ferrotungsten, tungsten metal, and wire" 3 short tons, valued at $122,906, was exported.

Almost no figures for foreign production in 1923 are at hand. It is supposed that the Chinese production, owing to military troubles, was somewhat smaller than that for 1922, when 56,951 piculs (1 picul equals 133⅓ pounds), equivalent to 4,275 short tons of ore carrying 60 per cent of tungsten trioxide, was exported. The world's production was probably equivalent to less than 6,000 short tons of ore carrying 60 per cent of tungsten trioxide.

RADIUM, URANIUM, AND VANADIUM

PRODUCTION

In 1923 the mining of uranium and vanadium ores was reduced to a very small industry in the United States, as the newly exploited uranium deposits in Katanga, Belgian Congo, came into large production. For several years vanadium has been produced in this country practically only as a by-product of radium production, and as the Peruvian vanadium deposits at Minasragra dominate the market as completely as those of Katanga dominate the radium market, mining for these metals in this country was doubly difficult.

During the year 2,025 short tons of uranium and vanadium ores were shipped in the United States, including a large quantity of concentrate from ores rich in vanadium and lean in uranium and some chemical concentrate from roscoelite ores that had been held at Sawpit, Colo., for several years. The ores are estimated to have contained about 21.5 short tons of uranium oxide (U_3O_8), containing 18.2 tons of uranium and 5.5 grams of radium (part of which is probably unrecoverable on account of the leanness of the ore) and 113 short tons of vanadium oxide (V_2O_5) containing 63.3 short tons of metallic vanadium. Only a nominal value can be given to the out-

put, possibly $150,000. During the year 12.212 grams of radium was isolated, part from residues left from work of 1922.

During 1922 929 tons of dry ore was mined and shipped. It contained 27.35 tons of U_3O_8 (23.2 tons of uranium), 7.015 grams of radium, and 46.27 tons of V_2O_5 (25.9 tons of vanadium) and was valued at $166,016.

In 1923 the Keystone Metals Reduction Co. sold some excellent carnotite ore that it had mined in 1922 on Polar Mesa, on the north side of the La Sal Mountains, Utah. The ore carried 4.77 to 5.51 per cent of uranium oxide and 4.69 to 6.17 per cent of vanadium oxide. It is interesting to note that the ores highest in U_3O_8 were lowest in V_2O_5 and vice versa. In New Mexico Leach & Leach experimented with the autunite-torbernite ores near Tyrone. At Rifle, Colo., ore almost free from carnotite but said to average about 3½ per cent of vanadium oxide was mined by the Vanadium Corporation of Colorado, and one shipment was made. The United States Radium Co. was the only American firm that isolated radium in 1923 from currently mined ores. The Standard Chemical Co. isolated radium from accumulated material and acted as agent in the United States for the Union minière du Haut-Katanga in the sale of radium. It operated experimentally its mill in Colorado, for the concentration of the vanadium-bearing sandstone associated with the carnotite deposits. The company continued the publication of its excellent review, "Radium." Although the Radium Co. of Colorado, at the time the Katanga product threatened the market, had just developed at Camp Maverick, near Gateway, Colo., the best bodies of ore in its history, the company found it necessary to wind up its affairs. Bunker & Holmes isolated 1,900 milligrams of radium from the ores and residues which the company had on hand. The Keystone Metals Reduction Co. had also developed fine bodies of ore carrying 5 to 6 per cent of uranium oxide but found it impossible to continue operations at a profit. The Pittsburgh Radium Corporation shipped its ores from Thompsons, Utah, to a plant it has established in the old cotton mill in Denver. The W. L. Cummings Chemical Co. did not operate during 1923.

The available figures on the world's production of vanadium are given below.

Approximate world's production of vanadium, 1918–1923

Year	Shipments of ore from countries other than United States			Vanadium content of ore and concentrates produced in the United States (short tons)	Total (short tons)
	Short tons	Percentage of V_2O_5	Vanadium contained (short tons)		
1918	[a] 2,407	19.10	257	276	533
1919	[a] 3,249	30.41	553	284	837
1920	[a] 11,158	20.43	1,277	527	1,804
1921	[a] 1,958	20.23	222	202	424
1922	818	17.18	78	26	104
1923	[a b] 3,513	19.8	390	63	453

[a] Peruvian ore only. During these years a little vanadium was produced in other countries, but the quantity was negligible.
[b] In 1923 the Peruvian exports included some asphaltite ash.

The production of vanadium ores in 1922, as represented by exports in foreign countries and shipments from the mines in this country, was as follows:

World's production of vanadium in 1922

Country	Ore (short tons)	Vanadium content	
		Percentage	Short tons
United States	929	2.8	26
Peru	24	9.5	2
British Southwest Africa	636	9.8	60
Northern Rhodesia	158	9.8	16
	1,747		104

IMPORTS AND EXPORTS

The imports of vanadium ore during 1923 are reported by the Bureau of Foreign and Domestic Commerce by quarters as follows:

Vanadium ore imported for consumption in the United States, 1923

Quarter	Pounds	Value
January–March	360,070	$27,032
April–June		
July–September	162,245	12,636
October–December	3,654,800	189,542
	4,177,115	229,210

By countries of origin—that is, by countries from which the ores were last billed—the general imports were as follows:

Vanadium ore imported into the United States in 1923, by countries

Country	Pounds	Value
Germany	108,518	$4,177
Canada	130,476	5,722
British South Africa	212,372	28,251
Peru	3,725,750	191,074
	4,177,116	229,224

Vanadium ore (steel-hardening) imported for consumption in the United States, 1918–1923

Year	Pounds	Value	Year	Pounds	Value
1918—July to December [a]	1,772,215	$5,333	1921	10,307,540	$543,061
1919	6,026,005	67,846	1922	611,170	86,776
1920	20,673,296	1,080,935	1923	4,177,115	229,210

[a] Not separately classified prior to July, 1918.

During 1923 no ferrovanadium was imported.

Value of uranium salts and oxide, including some radium salts, imported for consumption in the United States, 1917–1923

1917	$2,930	1921	$8,552
1918	274	1922	28,685
1919	12,960	1923	500,456
1920	3		

Uranium-radium ore (steel-hardening) imported for consumption in the United States, 1918–1923

Year	Pounds	Value	Year	Pounds	Value
1918—July to December [a]	157	$4,840	1921	250	$446
1919			1922		
1920	396	1,110	1923		

[a] Not separately classified prior to July, 1918.

The exports of ferrovanadium during 1923 are reported by the Bureau of Foreign and Domestic Commerce as follows:

Ferrovanadium exported from the United States in 1923

Destination	Pounds	Value
Belgium	3,360	$4,581
Canada	17,767	20,792
England	2,000	3,000
Japan	468	1,684
Kwangtung	4,023	5,961
Mexico	485	815
Scotland	22,746	27,000
Sweden	567	880

USES

The uses of uranium have not been much extended. Efforts are still being made to use it in steel, but the quantity absorbed is small. Considerable quantities of sodium uranate have been used in giving a yellowish tint to large building tiles. Uranium salts are used in coloring pottery and glass and very much smaller quantities in chemistry and photography.

Radium still finds its two uses in therapeutics and in illuminating watch dials, clock faces, etc.

Vanadium is the great toughener of steel. Whether it only removes impurities, gaseous or solid, or whether it also combines with the carbon or the iron or both, nothing else makes steel bear torsional strains and bending so well, for only after treatment with vanadium can steel bars so readily be tied into knots. For this use usually less than 1 per cent of vanadium is added to the steel, often as little as 0.2 per cent. High-speed steels are nearly all made with a vanadium content of 0.7 to 1.3 per cent. The other uses for vanadium are comparatively unimportant. A little has been used in medicines, inks, dyes, brass, bronze, bearing metals, and paint.

FERROVANADIUM

Ferrovanadium is made in this country by the following concerns:

Vanadium Corporation of America, 120 Broadway, New York, N. Y.
Standard Chemical Co., Forbes Street and Meyran Avenue, Pittsburgh, Pa.
Electrometallurgical Co. of America, 30 East Forty-second Street, New York, N. Y.
Metal Alloys (Inc.), Watervliet, N. Y.
Metal & Thermit Corporation, 120 Broadway, New York, N. Y.
York Metal & Alloys Co., 100 East Forty-second Street, New York, N. Y.

The first two companies have their own ore supplies, but the other four have to buy their ores. The York Metal & Alloys Co. and the Metal & Thermit Corporation have operated mostly on oxides or ferric vanadate made as a by-product in the isolation of radium, though during the Great War the York Metal & Alloys Co. operated a plant in Denver for the extraction of vanadium as ferric vanadate from La Sal Mountain ores lean in uranium. All the companies except the Metal & Thermit Corporation use electric furnaces in reducing their ores. The Metal & Thermit Corporation uses the aluminothermic process. The six companies supply the American demand and also export ferrovanadium to Europe, as the African ores, all that Europe gets, do not supply its needs.

The general requirements for ferrovanadium, as for all other ferroalloys, are that phosphorus and sulphur shall be low and preferably silicon and carbon shall also be low. In electric-furnace work carbon is likely to be high, though it can be brought down to 0.5 per cent, which is as low as by the aluminothermic process. It is difficult to make the ferroalloy carry more than 40 per cent of vanadium, and except in special brands the grades sold carry between 30 and 40 per cent.

The Vanadium Corporation of America makes three grades of ferrovanadium, names and specifications of which are as follows:

Open-hearth grade:	Per cent
V	30–40
Si (less than)	15
C (less than)	6
S (less than)	.50
P (less than)	.20

Crucible grade:	Per cent
V	35–40
Si (less than)	8
C (less than)	3
S (less than)	.30
P (less than)	.15

Primos special:	Per cent
V	40–45
Si (less than)	3
C	.50
S	.30
	.10
P	.10

At an increased price a ferroalloy can be produced that has still smaller percentages of impurities; thus silicon may be reduced to about 1 to 2 per cent, sulphur to about 0.1 per cent, and phosphorus to about 0.06 to 0.08 per cent. When the "open-hearth grade" sells at $3.50 a pound for the contained vanadium, the "crucible grade" sells at $3.65 a pound and the "Primos special" at $3.75.

The Standard Chemical Co. makes only one grade of ferrovanadium, and for it the specifications are these:

	Per cent
V	33–40
Si (maximum)	4.00
C (maximum)	.75
S (maximum)	.03
P (maximum)	.12

The silicon content may be reduced to 2 per cent maximum.

The Metal & Thermit Corporation also makes but one grade of ferrovanadium, for which its specifications are:

	Per cent
V (averaging between 38 and 39 per cent)	35–40
Si (under)	1.0
C	.5
S	.06
P	.08

Some manufacturers demand specifications about similar to those above but make the carbon 0.20 to 0.50 and add that the alloy shall contain no chromium nor tin. Chromium might be present if the alloy is made from some vanadinites or, possibly, from roscoelite, but tin, so far as I am aware, is an unknown constituent of vanadium ores.

VANADIUM ORES OF THE UNITED STATES

During 1923 vanadium ore as such was produced in the United States only at Rifle, Colo., and on Yellow Cat Wash, near Thompsons, Utah, and only small shipments were made.

The American ores have been produced chiefly as a by-product in the isolation of radium from the carnotite ores of Colorado and Utah. The deposits occur in loosely cemented sandstones. The radium-bearing mineral carnotite also carries about 20 per cent of vanadium oxide (V_2O_5) and is accompanied in American deposits by several other vanadium minerals, the principal of which is an imperfectly known mica-like mineral in exceedingly minute flakes a thousandth of an inch or less in diameter, filling spaces between the sand grains of the rock. Besides the micaceous mineral the ore carries hewettite and metahewettite (which have the same chemical composition but different optical properties), uvanite (hydrous uranium vanadate), vanoxite (black hydrous vanadium oxide), and other vanadium minerals.

The ores almost invariably carry more vanadium than uranium, and around the carnotite is an envelope of dark vanadium-bearing rock carrying as much as 8 per cent of vanadium oxide, though usually less, but most of the deposits are small, containing only a few hundred tons of ore carrying from 2 to 4 per cent of vanadium oxide. Most of the deposits are a long way from the railroad—40 to 70 miles over poor roads—so that mining and delivery are expensive.

On account of their low grade and high cost of mining and delivery the ores have yielded a profit only when worked in connection with radium. In the course of this process the vanadium was dissolved, obtained either as hydrous iron vanadate or as oxide, and by most companies sold to manufacturers of ferrovanadium. The product had a high degree of purity and was in good demand. The Standard Chemical Co., of Pittsburgh, and the Radium Corporation of Colorado, of Denver, made ferrovanadium from their own salts. The United States Radium Co. still makes vanadium salts as a by-product, and the Standard Chemical Co. experimented with the concentration of the mined ores that it had on hand in San Miguel County, Colo., 60 miles northwest of Placerville, for their vanadium content.

The Vanadium Corporation of Colorado has leased its property near Rifle to the United States Vanadium Co., which plans to build a concentration and reduction plant at Rifle for the manufacture of vanadic acid and iron vanadate. If the plant is successfully operated it may afford an outlet for other ores of similar type that will bear transportation—for instance, some of the ores of the La Sal Mountain region. The United States Vanadium Co. expects to erect during 1924, at some point in the East, a plant for the manufacture of ferrovanadium.

A somewhat similar type of ore is the roscoelite-bearing sandstone formerly extensively mined near Placerville and Vanadium, San Miguel County, Colo. These ores are very simple and contain no deleterious minerals. Bodies of ore could be selected that carried 3 per cent of vanadium oxide scattered through sandstone from 1 or 2 inches to a maximum of 36 feet thick. The bodies were generally flat lenses and some were several hundred feet wide. The Primos Chemical Co. worked the deposits for years with a plant at Vanadium for producing hydrous ferric vanadate, which was shipped East for reduction to ferrovanadium. For a while men having smaller capital mined portions of the ore that carried 3 per cent metallic vanadium for shipment to England. Later the Colorado Vanadium Co. established another plant at Sawpit. Then the Primos Chemical Co. sold its property and business to the Vanadium Corporation of America, which later closed the property, as it could produce its vanadium more cheaply from its Peruvian deposits. The Colorado Vanadium Co. was unsuccessful, and no work has been done in the area for several years. Opinions differ sharply as to whether commercially important quantities of ore remain.

These two types of vanadium deposits, wholly unknown elsewhere, produced from 1912 to 1918, inclusive, 2,750 metric tons of vanadium, against 3,398 tons of vanadium (official Peruvian figures) in shipments of ore from Peru.

The most widespread vanadium minerals, and therefore those with which the greatest number of prospectors and miners come into contact, are those that occur in the oxidized parts of lead veins. All are distinctly and many are brightly colored, so that they attract attention. Vanadinite, which may be taken as the type mineral of this class, contains lead, chlorine, vanadium, and oxygen. The other vanadium minerals also contain lead but may contain other elements; thus brackebuschite contains iron, manganese, and water, but no chlorine; dechenite contains no chlorine; descloizite contains zinc and water but no chlorine; cuprodescloizite contains copper, zinc, and water but no chlorine; endlichite contains arsenic; and mottramite, which is probably the same as psittacinite, contains copper and water but no chlorine. With the vanadium minerals are likely to occur also either or both pyromorphite, the lead chlor-phosphate, and mimetite, the lead chlor-arsenate. In North America wulfenite, the lead molybdate, almost everywhere accompanies vanadinite.

There may be almost any combination of these minerals in one deposit and a considerably different combination in another deposit close at hand. The deposits are usually so small that no considerable tonnage can be produced from any one mine, and the metallurgy, difficult at best, is thus complicated, because processes must be rearranged for each new combination. It seems probable, however, that

some process can be devised that will successfully treat all such ores. It is usually difficult to raise the content much above 8 per cent of vanadium oxide so that freight charges are comparatively high. These are the reasons why the market for lead vanadates has usually been poor. With improvements in metallurgy, such as the precipitation by steam of vanadium oxide in the presence of phosphorus and arsenic,[4] the separation of small quantities of phosphorus from vanadium by sodium aluminates, and the increased skill in electric-furnace metallurgy, antipathy to these ores is waning.

Small quantities of American vanadinites have been sold from time to time, and it seems probable that more will be sold in the future.

URANIUM AND VANADIUM ORES IN OTHER COUNTRIES

The deposits of uranium minerals in Katanga, Belgian Congo, were briefly described in Mineral Resources for 1922, and little new information concerning them has come to hand. The tyuyamunite (hydrous calcium-uranium vanadate) deposits in Ferghana, Russian Turkestan, were also described in that volume, and the Madagascar uranium deposits in Mineral Resources for 1921. Brief notes follow concerning other uranium and vanadium deposits that compete with American deposits.

URANIUM

CZECHOSLOVAKIA

The Czechoslovakian or Bohemian uranium deposits are probably the best known, because in them the Curies discovered radium, and they are close to popular lines of travel. They have been worked for hundreds of years and have often been described. The ore carries pitchblende and is taken from several mines close together at Jachymov (formerly called St. Joachimsthal), in the Erzgebirge, in the northwestern part of the country. The older mines are worked by a British company, through an arrangement with the Czechoslovakian Government.

The veins, thought to be Cretaceous or post-Cretaceous,[5] follow the strike and cut across schist with which is interbedded crystalline limestone. The veins contain calcite, dolomite, and quartz and include much brecciated country rock. They carry silver, arsenic, bismuth, cobalt, nickel and lead minerals, and marcasite with the pitchblende.

The total output of radium from 1909 to 1922 from these ores was 24.7 grams contained in salts. No later data are at hand.

The ores as mined are not rich in uranium and are carefully hand picked to a high grade; thus in 1919 the hand-picked ore amounted to only 10 metric tons and in 1920 to 76 metric tons. In 1921 3.2 grams and in 1922 2.2 grams of radium was produced. During 1923 local Czech papers reported that deposits of great promise were discovered at Durrmaul, in the region west of Marienbad, on the east slopes of the Bayerischer Wald.[6] Pitchblende was found at a shallow depth in certain old copper-bearing properties that have

[4] Doerner, H. A., Separation of arsenic and phosphorus from vanadium: Ind. and Eng. Chemistry, vol. 15, p. 104, October, 1923.

[5] Babanek, Franz, Ueber die Erzführung der Joachimsthaler Gänge: Oesterr. Zeitschr. Berg u. Hüttenwesen, vol. 32, pp. 1–5, 21–24, 61–62, 1881.

[6] Yoder, W. A., New radium deposits discovered in Czechoslovakia: Dept. Commerce Trade Note 91, Feb. 5, 1924.

long lain idle. The ore is stated to average 5.5 per cent of uranium, or 0.0177 gram of radium to the ton.

A joint stock company, the Böhmische Montan-Aktiengesellschaft, has been organized with a stock capital of 11,000,000 Czech crowns, for the purpose of developing the deposits; the headquarters of the company are at Hotel Neptun, Marienbad. Before the end of 1923 three properties in this region had been surveyed and granted by the Government for purposes of development.

PORTUGAL

Uranium-bearing veins have been worked in Portugal for a number of years. Most of the ore has gone to France for treatment, but some has gone to England.

The bedrock in the region in which the uranium-bearing veins are found consists entirely of granite, which occupies a considerable area east and west of Vizeu.[7] The granite is of two varieties; one contains 67 per cent of silica, carries black mica, and is somewhat porphyritic; the other is a granulite carrying 70 to 74 per cent of silica, with muscovite or with two micas, and the quartz has a bipyramidal tendency. Quartz veins that carry wolframite and cassiterite and those that carry radium minerals occur only in the second type.

The veins form a series of parallel groups, which, successively eastward from the Sierra Caramullo (Duparc says from east to west, evidently an error), are as follows:

Sega group, immediately east of the Sierra. Include the veins of Menninho and Morengueiro, on which little important work has been done.

Sabougosa group, of numerous known veins but little exploitation.

Canmas-Senhorim-Cabanas group, on which is the Urgeirica mine and other smaller workings.

Mangualde group, farther east.

Maceira-Troncoso group. One vein is worked.

Guarda group. This is the most eastern group.

In the outcrops autunite and torbernite are found in the inclosing granite but not in the veins, and the exploitable parts of the veins are indicated by these minerals in the granite. The granite is decayed and porous where impregnated with the uranium minerals. The fissures in which the veins are found are attributed to contraction of the granite and in less degree to "dynamic phenomena." In places gouge accompanies the veins. The depths to which the deposits reach are unknown, but the Urgeirica mine is said to be worked down to 100 meters. Autunite and torbernite are found for 15 to 20 meters from the surface, below which is a barren zone of a few meters; under the barren zone a black or grayish amorphous mineral is found persistently which is richer in depth. An analysis showed uranium, phosphoric acid, and smaller quantities of other elements. The black mineral forms nests and small masses in the quartz and is irregularly distributed.

In general the ore as mined is lean, and the run-of-mine ore rarely contains more than 2 per cent of uranium oxide, but the ores carrying the black mineral may contain 5 per cent. The cost of transportation

[7] Duparc, L., Sur les filons et les minerais radioactifs d'urane du Portugal: Archives sci. phys., vol. 5, pp. 79–82, July–August, 1923.

is so high that efforts to concentrate the ore chemically at the mine have been made. They succeeded well with the black minerals, but not with the autunite-torbernite ore.

Some of the veins carry both tungsten and uranium minerals.

The Portuguese production of ore is reported to have been, in 1919, 1,380 metric tons; 1920, 437 metric tons; 1921, 1,032 metric tons, all with a content of uranium oxide between 0.5 and 1.5 per cent. The ores were shipped to France and Great Britain for treatment. If the average is taken as 1 per cent of uranium oxide, the total radium content would be about 7.3 grams.

GREAT BRITAIN

Uranium minerals, mostly autunite (hydrous calcium phosphate) and torbernite (hydrous copper phosphate), probably alteration products of pitchblende (uranium oxide with some rare earths), in the upper part of the tin and copper-bearing veins of Cornwall have been known for many years. In two mines particularly—the South Terras mine, in the Fal Valley, a little south of Terras Bridge, near Grampound Road station, and the Trenwith mine, 2 miles from St. Ives—considerable amounts of pitchblende have been found. The Trenwith mine carried so much pitchblende in its upper workings that the copper ores were penalized for it, and it was picked out and thrown on the dumps, which were later re-sorted when the mineral became more valuable.[8]

The Trenwith mine has been operated by the St. Ives Consolidated Co., and radium was made by a subsidiary company, the British Radium Corporation, at Limehouse, London. The South Terras mine has been operated by the Société industrielle de radium, which formerly shipped its ores to Gif, near Paris, for treatment. A plant for the isolation of radium was completed at the mine in 1923 and is said to have a capacity of 300 to 400 milligrams a month. A concentration plant was also built.

During the 10 years from 1913 to 1922 the Cornish production was as follows:

Uranium ore produced in Cornwall, 1913–1922, in metric tons

1913	97	1917	13
1914	350	1920	61
1915	83	1921	77
1916	52	1922	399

None was produced in 1918 or 1919. The ore is supposed to have carried about 2 per cent of uranium oxide. On such an estimate the ore held about 5.8 grams of radium, from which it would seem that about 4.6 grams or more of radium should have been recovered. In 1921 Great Britain imported 255 metric tons of uranium ore from Portugal.

MADAGASCAR

Autunite was discovered in Madagascar in 1907, and betafite, a complex columbate, tantalate, and titanate of uranium, containing 18 to 25 per cent of uranium oxide, was discovered in 1908. The betafite is found in pegmatite dikes of great age and deeply decayed.

[8] Penrose, R. A. F., The pitchblende of Cornwall, England: Econ. Geology, vol. 10, pp. 166–167, 1915.

The drainage from the dikes flowed during Tertiary time into the then existing Lake Antsirabe, where the uranium was precipitated as autunite and uranocircite (hydrous barium-uranium phosphate) in the peaty muds. The sediments have been mined at Vinaninkarena, and some ore has been exported to France. Betafite has also been shipped in considerable quantity.

The shipments of "uraniferous earth"—that is, the old lake-bed material carrying autunite and uranocircite—were as follows:

"Uraniferous earth" shipped from Madagascar, 1909–1922, in kilograms

1909	500	1921	3,822
1910	2,492	1922	2
1911	29,125		
1912	846		36,890
1913	103		

The uranium content is unknown. No shipments were made in 1914–1920. The exports of betafite have been as follows:

Betafite exported from Madagascar, 1912–1923

1912	kilograms 11	1919	metric tons 10.15
1913	metric tons 5	1920	do 5.15
1914	do 8.86	1921	do 5.94
1915	do 1.21	1922	do 15.62
1916	do 1.23	1923	do 20.36
1917	do 7.28		

None was exported in 1918. It requires from 12 to 20 tons of betafite to produce a gram of radium.

Remarkable facts connected with the deposits are that the betafite may have as little as 37 per cent and from that to 100 per cent of the radium required for equilibrium with the uranium, the content depending on the degree of hydration of the mineral,[9] and the autunite deposits carry more than the normal quantity of radium.[10]

If the "uraniferous earth" carried 2 per cent of uranium oxide and the betafite yielded a gram of radium to about 16 tons of the mineral, the exports carried about 7 grams of radium.

TONKIN (INDO-CHINA)

Autunite is found in Beau-Site, Cao-Son, Nguyen-Binh, and the Pia Ouac massif, in the military territory of Cao-Bang, Tonkin, near the border of Kwangsi, China. One ton was shipped to France in 1910 and 2 tons in 1911.[11]

SOUTH AUSTRALIA

Uranium ores occur in some quantity at two places in South Australia. One locality is at Radium Hill, 20 miles east-southeast of Olary station on the Petersburg-Broken Hill Railroad and about the same distance west of the New South Wales boundary. It is approximately in 140° 40′ east longitude and 31° 20′ south latitude. The other locality is between Mounts Painter and Pitt, in the Flinders Range, in about 139° 15′ east longitude and 30° 20′ south

[9] Lacroix, A., Minéralogie de Madagascar, vol. 2, p. 131, 1922.
[10] Lacroix, A., Les industries minérales nonmetallifères à Madagascar: Bull. écon. de Madagascar, vol. 17, pp. 48 et seq., 1920.
[11] Statistiques de l'industrie minière dans les colonies françaises pendant l'année, 1910, pp. 150–151; idem, 1911, p. 173. 173.

latitude, about 80 miles a little south of east from Farina station on the Great Northern Railway and perhaps 30 miles northwest of Lake Frome.

The deposits near Olary were discovered in 1906 and consist of several more or less parallel lodes, 25 to 50 feet apart and 2 to 5 feet wide, cutting gneissic granite and granite schist, which are intruded by granite and diorite. Carnotite is found in cracks, and radium is present in dark minerals whose character is not well understood. Rutile, ilmenite, tscheffkinite(?), magnetite, biotite, and quartz are found in the lode, which seems to carry from 0.28[12] to 1.32[13] per cent of uranium oxide. The Radium Hill Co. worked the deposits about 1912–13 and extracted nearly half a gram of radium.

At Mount Painter autunite and torbernite are found in ferruginous deposits of uncertain character in crushed granite and gneiss.[14] Quartz, calcite (?), fluorite, barite, psilomelane, fergusonite, monazite, uranophane, gummite, uranium ocher, and carnotite are said to be also found in the deposit. The ores in general were said to carry only 0.2 to 0.5 per cent of UO_3,[15] though a shipment of 60 long tons carried 10 per cent of U_3O_8;[16] 16 hundredweight carried from 5 to 20 per cent of U_3O_8; 52 bags, 5 per cent; 346 bags, 3.03 per cent; and 174 bags, 3.14 per cent. These ores probably carried about 260 milligrams of radium, making the entire Australian output of radium three-quarters of a gram. The Radium Extraction Co., which attempted to work them, was financially unsuccessful.

In 1923 a new company, the Radium & Rare Earths Treatment Co.,[16] was formed in Melbourne to operate both sets of deposits; Sir Douglas Mawson is technical adviser to the company.

OTHER COUNTRIES

No considerable quantities of uranium ores are known in countries other than those already referred to.

In Ontario a number of pegmatite dikes that carry uraninite occur near Parry Sound and near Monmouth, in the Haliburton district; euxenite is found in a pegmatite dike in the county of Lanark; hatchettolite in pegmatite at Hybla, Monteagle Township, Hastings County; and ellsworthite, a new mineral containing 18.5 per cent of UO_3, with columbium, tantalum, titanium, and calcium, in another pegmatite near Hybla. A few occurrences of only mineralogic interest have been noted in Quebec.

In India some uraninite is found in pegmatite from which mica is mined near Pichhli and Banekhap, in the Gaya district, and masses have weighed as much as 36 pounds. Samarskite in masses weighing as much as 200 pounds has been found in the Sankara mica mine, in a pegmatite at Rapur Taluq, Nellore district, Madras.

In Brazil polycrase that grades into euxenite is found in a pegmatite in Minas Geraes, and many smaller occurrences of uranium

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[12] Brown, H. Y. L., quoted by Gee, L. C. E., The occurrence of uranium (radio-active) ores and other rare metals and minerals in South Australia, p. 10, Adelaide, South Australia, Dept. Mines, 1911.

[13] Radcliffe, S., quoted in Min. Jour. (London), vol. 92, p. 268, 1911.

[14] Ward, L. K., Review of mining operations, State of South Australia, half year ended Dec. 31, 1912, p. 27, 1913.

[15] Min. Jour. (London), 1911, p. 27.

[16] Ind. Austral. and Min. Standard, Melbourne, vol. 71, p. 238, 1924.

minerals in pegmatite are known in other parts of the world, but no pegmatite has yet yielded any considerable quantity of uranium.

In Mexico pitchblende has been found with gold in one or more veins on the Terrazas estate, about 90 miles west and a little south of Chihuahua, at Placer de Guadalupe, Chihuahua, but it has not yet been shown to be present in commercially valuable quantities.

VANADIUM

PERU

The largest source of vanadium has been and still is a unique deposit at Minasragra, Peru, where a sulphide mineral, patronite, carrying an excess of sulphur, was discovered with asphaltite and small quantities of sulphides of molybdenum, nickel, and iron. Nowhere else in the world has a single specimen of patronite been found. The patronite has now all been mined, and the remaining ore is mostly an indistinguishable hodgepodge of dark minerals, with which are the hydrous calcium vanadates, hewettite (red), pascoite (orange), fernandinite (dull green), and melanovanadite (dark brown), and the blue hydrous sulphate, minasragrite. The deposit, which has a gypsum gangue, replaces and is inclosed in shale. For a number of years more than half of the world's vanadium came from this deposit, and during the last two years it has yielded a larger part. The richest ores, which carried 46 per cent of vanadium oxide after roasting and being made ready for shipment, have been mined and those now mined carry 14 to 23 per cent, and the supply of this grade is by no means unlimited.

The deposit is at an altitude of about 14,000 feet in a barren, desolate country, 26 miles from the railroad at Ricran, a point 230 miles from the coast at Callao.

The property was opened and developed by the American Vanadium Co., of Pittsburgh, but was bought by the Vanadium Corporation of America, which now owns and operates the property and ships the ore to its own smelter at Bridgeville, near Pittsburgh. It has been the policy of both companies to mine large quantities of ore ahead of demand and store it at the Bridgeville plant, so that shipments have not been uniform either in gross tonnage or in contained vanadium.

At first the losses in smelting were very great, as much as 65 per cent, for smelting of this type was pioneer work, and knowledge was acquired at considerable cost. The ore carried sulphur, nickel, and molybdenum, all of which had to be eliminated. A number of smelting processes were tried, and under Dr. B. D. Saklatwalla electric smelting has been brought to a high efficiency, so that recoveries are comparable to those in other branches of metallurgy under skilled management. The slags of former days are all being reworked, and great quantities of vanadium have been recovered from them—more than a year's supply for the world. Doctor Saklatwalla has developed a tightly inclosed electric furnace with a closely controlled input of electricity, which he says will enable him to smelt ores carrying as little as 1 per cent of vanadium. At present the company can supply the world's demand for vanadium from its own deposit and stocks, including slags.

Vanadium is found with asphaltites in various parts of the world—the United States, Cuba, Sweden (called there "kolm"), Argentina, and Peru—but so far a production of vanadium has been made only from the Peruvian asphaltites. They carry from 0.1 to 1.06 per cent of vanadium oxide,[17] which collects in the ash. The vanadium content of the ash is usually low, and though clean ash may carry as much as 20 per cent of vanadium oxide, it is very difficult to burn the carbon entirely, and the output is of lower grade. It is these asphaltites, mistaken for coal, that have given rise to the numerous references to vanadium in coal. The largest deposits are in the Province of Yauli, Peru, where the asphaltite has been used in large quantity to burn as a substitute for coal. Several tons of ash is reported to have been shipped to England about 20 years ago, and some has been shipped to the United States during the last few years, but the total quantity of vanadium contained is small. No large output in the near future seems probable.

A potential source of vanadium is a carbonaceous shale found in the Province of Jauja, Peru. The shale is more than 30 feet thick and has a great length of outcrop. It contains much smutty black material, phosphate nodules, and fossil ammonites. Baragwanath[18] says that the shale has an average content of more than 1 per cent of vanadium oxide. The vanadium can be concentrated by separating the phosphoric nodules, which seem to contain most of the metal. This shale deposit is so extensive that, should demand justify, very large operations could be carried on with probable savings per unit output.

AFRICA

Recently considerable mottramite has been shipped from Otavi, in the Southwest Africa Protectorate. For a time the shipments were made at the rate of 50 tons a month, but during 1923 they are said to have been somewhat increased. Some descloizite is also being shipped. These ores are said to carry about 10 per cent of vanadium oxide. An estimate of 1,000 long tons of vanadium in ores in sight has been reported. The shipments have been, in 1920, 365 metric tons; 1921, 660 metric tons; 1922, 577 metric tons. Vanadinites are mined in Northern Rhodesia at Broken Hill. Official figures for shipments from the colony are as follows: 1921, 56 metric tons; 1922, 143 metric tons; 1923, 83 metric tons. The ores are said to carry about 10 per cent of vanadium oxide, and the ores received in this country are said to carry 1 per cent of phosphorus. Two or three carloads of vanadium were shipped from Ottoshoop, Transvaal, during the year. The South African ores are said eventually to go largely to the Thermo-Electric Ore Reduction Corporation (Ltd.), Luton, England, but some has come to this country, and larger lots have gone to Germany for the extraction of vanadium oxide.

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[17] Hewett, D. F., Vanadium deposits in Peru: Am. Inst. Min. Eng. Trans., vol. 40, pp. 274–299, 1910.

[18] Baragwanath, J. G., The vanadiferous asphaltites of central Peru: Eng. and Min. Jour., vol. 111, pp. 778–781, 1921.

SECONDARY METALS

By J. P. Dunlop

INTRODUCTION

SCOPE OF REPORT

"Secondary metals" are those recovered from scrap metal, sweepings, skimmings, and drosses and are so called to distinguish them from metals derived directly from ores, which are termed "primary metals." The distinction does not imply that secondary metals are of inferior quality, for metals derived either from ore or from waste material vary in purity and in adaptability to use in making certain products. The reports to the United States Geological Survey now include secondary copper, zinc, lead, tin, antimony, aluminum, and nickel. The figures obtained by the Survey are supplemental to those on primary metals and are given to enable producers and consumers to form a more comprehensive idea of the quantities of metal available for consumption; in fact, they constitute an essential addition to those given in the seven general reports on primary metals.

RECOVERY OF WASTE MATERIAL

The collection of waste material is an established branch of industry, which involves the gathering, sorting, and shipping of waste of an estimated value of more than a billion dollars yearly and in which many large fortunes have been made. It is now a unified, progressive, and honest trade with many ramifications and an enormous volume of business, rapidly growing and being conducted with increasing efficiency and increasing benefit to the country. Better-equipped and larger plants handle the material, and technical methods of handling and using waste are rapidly superseding ignorance and guesswork.[1] Shipments of metallic waste from country districts, which were comparatively small in 1922, were larger in 1923, but offerings of scrap metals by the War and Navy departments of the United States decreased to normal quantities, so that manufacturing plants, foundries, and railways furnished nearly all the waste metals recovered. The abundant supply of scrap metal in Europe, which has undoubtedly affected the consumption of new metal, will soon be reduced to normal proportions. These stocks of waste metals, especially brass, were larger than had been estimated but have now been greatly depleted by use and by exports.

[1] Merica, P. D. (International Nickel Co.), Research in the nonferrous industry—the scrap problem: Brass World, vol. 19, pp. 400–402, December, 1923.

An article by W. M. Corse, chairman of the division of research extension of the National Research Council, given in the report on secondary metals in Mineral Resources for 1922, emphasizes the importance of remelted material to metal users and producers.

The chapters on secondary metals in Mineral Resources for 1918 and 1919 contain much information regarding the collection of waste material. Various trade papers, such as the Waste Trade Journal, Daily Metal Trade, Brass World, American Metal Market, Foundry, Iron Age, Iron Trade Review, Metal Industry, and Daily Metal Reporter, also contain valuable information relating to prices and marketing of scrap metal and drosses and technical information relating to the proper use of old metals. Some idea of the questions to which replies are given by technical and trade papers are set forth in a statistical survey of difficulties encountered by nonferrous foundries over a period of years, by Adolph Bregman, published in Metal Industry, July, 1922, page 269.

CLASSIFICATION OF OLD METALS

The classification of old metals drawn up by the metal division of the National Association of Waste Material Dealers (Times Building, New York City) and changed from time to time as was found desirable has become the standard with both dealers and manufacturers all over the United States. Its latest classification (Circular G) is effective until November 1, 1924, when a new circular will be issued. The metal division, as well as all other divisions of the association, has a grievance committee, whose duty it is to adjust differences between members or to arrange arbitration if it becomes necessary. This division has in recent years been able to remedy trade abuses, and its constructive work has attracted to it practically all dealers in metal wastes, so that the association has steadily increased in members and prestige. The present classification follows:

Standard classification for old metals effective from Nov. 1, 1923, to Nov. 1, 1924.

1. Delivery:

(*a*) Delivery of more or less on the specified quantity up to 2½ per cent is permissible.

(*b*) If the term "about" is used, it is understood that 5 per cent more or less of the quantity may be delivered.

(*c*) Should the seller fail to make deliveries as specified in the contract, the purchaser has the option of canceling all of the uncompleted deliveries or holding the seller for whatever damages the purchaser may sustain through failure to deliver, and if unable to agree on the amount of damages, the arbitration committee of the National Association of Waste Material Dealers (Inc.), appointed for this purpose, to determine the amount of such damages.

(*d*) In the event that buyer should claim the goods delivered on a contract are not up to the proper standard, and the seller claims that they are a proper delivery, the dispute shall be referred to the arbitration committee of the National Association of Waste Material Dealers (Inc.), to be appointed for that purpose.

(*e*) A contract for a carload, unless otherwise agreed upon, shall mean the minimum quantity recognized by the official classification tariff of the district in which the seller is located.

(*f*) A ton shall be understood to be 2,000 pounds, unless otherwise specified.

(*g*) If, through embargo, a delivery can not be made at the time specified, the contract shall remain valid and shall be completed immediately on the lifting of the embargo, and terms of said contract shall not be changed.

(*h*) In case of a difference in weight and the seller is not willing to accept buyer's weights, a sworn weigher shall be employed, and the party most in error must pay the costs of handling and weighing.

2. Heavy copper:
   This shall consist of copper not less than one-sixteenth inch thick and may include trolley wire, heavy field wire, heavy armature wire that is not tangled, and also new copper clippings and punchings, untinned and clean, and copper segments that are clean.
3. No. 1 copper wire:
   To consist of clean untinned copper wire not smaller than No. 16 B. & S. wire gage, to be free from burnt copper wire which is brittle and all foreign substances.
4. No. 2 copper wire:
   To consist of miscellaneous clean copper wire such as of necessity would be taken out of the heavy copper and the No. 1 copper wire, but to be free of hair and burnt wire which is brittle.
5. Light copper:
   Shall consist of the bottoms of kettles and boilers, bathtub linings, hair wire, burnt copper wire which is brittle, roofing copper and similar copper, free from radiators, brass, lead, and solder connections, readily removable iron, old electrotype shells, and free of excessive paint, tar, and scale.
6. Composition or red brass:
   Shall consist of red scrap brass, valves, machinery bearings, and other parts of machinery, including miscellaneous castings made of copper, tin, zinc, and/or lead, no piece to measure more than 12 inches over any one part, not to weigh over 60 pounds, to be free of aluminum and manganese, also free of railroad boxes, cocks and faucets, gates, pot pieces, ingots, and burned brass.
7. Railroad bearing:
   Shall consist of railroad boxes or car-journal bearings, must be old standard used scrap, free of yellow boxes, plastic and similar bearings, also iron-backed boxes, and must be free of babbitt; also free of excessive grease and dirt.
8. Cocks and faucets:
   To be mixed red and yellow, free of gas cocks and beer faucets; shall be at least half red.
9. Heavy yellow brass:
   Shall consist of heavy brass castings, rolled brass, rod brass ends, brass screws, and tinned or nickel-plated brass tubing; to be free of iron and dirt, and must be in pieces not too large for crucibles; no piece to measure more than 12 inches over any one part. Must also be free of aluminum and manganese mixtures. Condenser tubes shall not be considered as heavy brass.
10. Light brass:
    Shall consist of light sheet brass, forks and spoons, miscellaneous brass that is too light for heavy, to be free of any visible iron, radiators, gun shells containing paper, ashes, or iron, loaded lamp bases, and clock works.
11. New brass clippings:
    Shall consist of the cuttings of new sheet brass, to be absolutely clean and free from any foreign substances.
12. Brass tubing:
    Shall consist of brass tubing, free of nickel plating, tinned, soldered, or tubes with cast-brass connections. To be sound, clean tubes, free of sediment, and condenser tubes.
13. No. 1 composition turnings:
    To be free of aluminum, manganese, plastic, and yellow brass turnings, not to contain over 2 per cent iron, to be free of grindings or foreign material, especially babbitt, and free from adulterations made to resemble metal. Turnings not according to this specification subject to sample

14. No. 1 yellow brass turnings:
Shall consist of strictly rod turnings, free of aluminum, manganese, composition, and tobin turnings. Not to contain over 3 per cent of iron, oil, or other moisture, to be free of grindings and babbitts. To avoid dispute, to be sold subject to sample.
15. No. 1 pewter:
Shall consist of tableware and soda-fountain boxes, but in any case must test 84 per cent tin. Siphon tops to be treated for separately.
16. Auto radiators (copper and brass):
Ford, 2 pounds deduction on a Ford plate; ¾ pound for each iron water connection; 1 pound for each side sheet-iron strip. All other radiators to be subject to deduction for actual iron.
17. Zinc:
Must consist of clean sheet and cast zinc; also cast batteries, to be free of loose oxide and dross, sal ammoniac cans, and other foreign materials.
18. Tin foil:
Shall consist of pure foil free of lead composition and other foreign ingredients and matters.
19. Electrotype shells:
Must be hand picked and free of loose dross and chunks of dross.
20. Battery lead plates:
Shall consist of dry-battery lead plates, moisture not to exceed 1 per cent, allowance to be made for wood, rubber, paper, and excess moisture.
21. New sheet aluminum clippings:
Shall consist of new sheet aluminum and cuttings. Must be free from oil, grease, and any other foreign substances. Must be guaranteed not less than 98 per cent pure aluminum.
22. Aluminum wire:
Shall consist of aluminum wire guaranteed 98 to 99 per cent pure aluminum and must be free from corrosion and any other foreign substance.
23. Painted sheet aluminum:
Shall consist of painted sheet aluminum and must be absolutely free from iron, dirt, or any other foreign substance.
24. Aluminum castings:
Shall consist of aluminum castings, free from iron, babbitt, brass, and any other foreign substance. Must not exceed 2 per cent of oil and grease.
25. Old sheet aluminum:
Shall consist of old and manufactured sheet aluminum. Must be free from painted sheet aluminum, iron, dirt, and any other foreign substance.
26. Aluminum borings:
To avoid dispute, should be sold subject to sample.
27. Aluminum foil:
Shall consist of pure aluminum foil, free from paper and any foreign ingredients.
28. Babbitt metal:
Shall contain bearing metal of all kinds. Shall not contain scrap hard metal, Allen metal (which is copper and lead alloy), die cast, zinc boxes, or type metal.
29. Monel metal scrap:
Must be in sheets, clippings, castings, bars, or rods. Must be free of iron and other foreign materials. To avoid disputes, to be sold subject to sample.
30. Monel metal turnings:
Must be free of iron and undue percentage of oil and moisture. To avoid disputes, to be sold subject to sample.
31. Packages:
Shall be good strong packages, suitable for shipment, and each package to be plainly marked with the gross and tare weights so that when packages reach their destination their weights can be easily checked.
When goods are not packed according to the above specifications, and shipper wants his rejections returned, the cost of labor shall be charged to the shipper.

REVIEW OF THE SECONDARY-METAL INDUSTRY IN 1923

MARKET CONDITIONS

Owing to better business conditions and higher though variable average prices in 1923, the recoveries from scrap metals and drosses increased about 19 per cent, and the value increased in a much higher ratio, as shown by the table on page 267.

Stocks of metal, which had accumulated at dealers' warehouses and at secondary-metal refineries, were greatly reduced during the year. White-metal scrap and drosses were in demand, for the supply of primary lead was low and the price of lead and tin much higher. There were ample supplies of secondary copper and No. 1 composition scrap, and the large production and slump in the price of primary copper made the demand smaller during the last part of 1923. On the whole, however, the market showed great strength in absorbing the tremendous accumulations of brass scrap and the current waste from many active manufacturing plants and scrapped equipment.

The factors that made the recovery and consumption of scrap metals so much greater than in 1922 were the large expansion of the automobile industry, the greatly increased buying by railways of new equipment and the repair of old engines and cars, the continuation of record building operations, the increased output of tin plate and galvanized steel, and the increased operations at most manufacturing plants. More scrap was used in castings, and greater use of babbitt, solder, and bearing metals always attends any increase in general industry.

Competition in the purchase of both scrap and drosses was keen, and much of the recovered or remelted material was sold on a close margin of profit. The comparatively wide spread of the price of most metals during the year gave opportunities for speculation, but most dealers bought cautiously. On the whole the business for the year was satisfactory, though there probably was not the proportionate increase of profit that should have resulted from the marked increase in the consumption of scrap metals.

Though the increase in the quantity of waste material handled was large, there was practically no increase in the number of dealers and refiners of secondary metals.

Large companies with ample capital, adequately equipped, many of them having widely distributed plants or selling agencies, handle the bulk of the nonferrous scrap and drosses. Buying large quantities of all kinds of scrap metals and drosses and employing metallurgists and chemists, they can use scrap to the best advantage and sell metals and alloys on close specifications or by brands. It is natural that the secondary-metal industry will tend more and more to consolidation, for that has happened in other important industries seeking more stable business conditions and less cutthroat competition. The change will bring a steadier supply of guaranteed metals and alloys and induce more foundries and other plants to buy alloys and composition metal instead of virgin pig metals and scrap metals.

Dealers in and refiners of waste metals and drosses can not buy such material as cheaply as in the past. Manufacturers are better informed regarding the value of all kinds of scrap and drosses, and competition is keen. The sellers know the spot market as well as the buyers, though naturally they are not usually as well informed regarding stocks and future conditions. The business ethics of the waste-trade industry have radically changed, and rigorous competition is causing rapid expansion in the size of plants and in the reliability of their products.

Although the secondary-metal trade may show more profit in 1924 than in 1923, it is not probable that business will be as large. Building operations, though still much above normal, are slowing up, railways have brought their repair work up to date and purchased about enough equipment to handle their expected traffic, and the tendency in the automotive trade is to curtail operations.

PRICES OF SOME SCRAP METAL AND ALLOYS

The dealers' average buying price in New York of heavy scrap copper increased from 12 cents a pound in January, 1923, to 14.3 cents in March, when the turn of the market was reached, and declined to 12 cents in May. A further decline to 11.6 cents occurred in June. Prices advanced slightly in July, decreased again in August and September, increased for a few days in October, but declined again to the lowest point in the year at the end of the month, in November reached 11 cents a pound, and then declined to a steady price of 10.6 cents for the month of December. The average price ranged from 10.1 to 14.3 cents a pound.

No. 1 composition scrap showed the same unstable range of price. It began at 9.55 cents in January, was highest at 12.25 cents in March and lowest at 8.25 cents in October, and ended the year at 8.75 cents in December.

The price of heavy lead scrap began the year at 6.10 cents a pound and reached 7.25 cents, the highest quotation of the year, in March. In May as low as 5.85 cents a pound was paid, and in July it slumped to 4.85 cents. The upward trend commencing in July and continuing until October was followed by a reaction in November. In December prices advanced, and the final figure was 6.6 cents a pound. The range of prices during the year was 2.4 cents.

The variation in the price of scrap zinc was only 1.15 cents. The price was 4.35 cents a pound in January and as little as 4.10 cents in August, October, November, and December. A sharp advance occurred during March, but the variation in price during the period July to December was only 0.15 cent a pound. The highest price of the year (5.25 cents) was reached in March, and the price at the end of December was 4.10 cents.

The price of secondary tin followed the trend of prices for primary tin, and block-tin pipe was quoted as high as 44 cents a pound in March and as low as 31 cents in July.

The prices of scrap aluminum and No. 12 alloy were firm, and the quotations for scrap aluminum castings ranged from 20 cents a pound at the middle of 1923 to 17 cents in November and December.

Average scrap-metal prices, 1923, in cents per pound [a]

[New York dealers' weekly average buying prices]

	Heavy copper	No. 1 composition	Heavy lead	Scrap zinc	Block-tin pipe
Jan. 6	12.10	9.55	6.10	4.35	33.00
13	12.00	9.50	6.35	4.50	34.00
20	12.60	9.50	6.50	4.50	34.00
27	12.20	9.50	7.00	4.35	35.00
Feb. 3	12.35	9.75	6.75	4.60	35.00
10	12.35	9.75	7.00	4.75	35.00
17	12.60	10.00	7.00	4.75	36.00
24	13.35	10.50	7.00	4.75	38.00
Mar. 3	14.25	11.25	7.25	5.20	41.00
10	14.00	11.25	7.25	5.25	43.00
17	14.25	12.25	7.25	5.25	44.00
24	14.30	12.25	7.25	5.25	43.00
31	14.25	12.00	7.25	5.00	41.00
Apr. 7	14.20	12.00	7.25	4.85	41.00
14	14.00	11.85	7.25	5.00	41.00
21	14.00	11.50	7.25	5.00	39.00
28	13.60	11.25	7.10	4.75	38.00
May 5	12.75	10.25	6.35	4.75	38.00
12	13.00	10.25	6.10	4.60	38.00
19	12.00	9.35	5.85	4.50	35.00
26	12.25	9.35	6.00	4.60	35.00
June 2	11.75	9.25	6.00	4.60	35.00
9	12.00	9.25	5.85	4.50	35.00
16	12.25	9.75	5.85	4.35	35.00
23	12.00	9.60	5.85	4.35	35.00
30	11.60	9.25	5.85	4.25	34.00
July 7	11.75	9.25	5.35	4.25	32.00
14	11.75	9.25	4.85	4.25	31.00
21	11.75	9.50	4.85	4.25	31.00
28	11.75	9.25	5.20	4.25	32.00
Aug. 4	11.50	9.25	5.35	4.25	32.00
11	11.50	9.00	5.60	4.10	32.00
18	11.25	8.75	5.60	4.10	32.00
25	11.60	9.35	5.75	4.35	33.00
Sept. 1	11.35	9.10	6.10	4.25	34.00
8	11.25	9.25	6.10	4.25	35.00
15	11.50	9.25	6.20	4.25	35.00
22	11.10	9.00	6.20	4.25	35.00
29	10.50	9.25	6.10	4.25	35.00
Oct. 6	10.75	8.75	6.10	4.25	35.00
13	10.50	8.60	6.10	4.10	35.00
20	10.25	8.50	6.10	4.25	35.00
27	10.10	8.25	6.10	4.10	35.00
Nov. 3	10.10	8.25	5.85	4.10	35.00
10	10.50	8.50	5.85	4.10	36.00
17	11.00	9.00	5.85	4.25	37.50
24	10.50	9.00	5.85	4.10	36.00
Dec. 1	10.50	8.85	5.85	4.10	37.50
8	10.60	9.00	6.50	4.10	42.00
15	10.60	9.00	6.35	4.10	42.00
22	10.60	9.00	6.60	4.10	42.00
29	10.60	8.75	6.60	4.10	42.00

[a] Waste Trade Journal, New York, Jan. 19, 1924.

SECONDARY METALS RECOVERED

The quantity of the metals contained in numerous alloys made partly or wholly from secondary material can not be definitely ascertained. The figures given as the result of the annual inquiry made by the Geological Survey are only approximate, but they constitute the sole available data on an important industry.

The increase in the value of the secondary metals, exclusive of gold, silver, platinum, iron, steel, and ferroalloys, recovered in the United States in 1922 was due to the higher average price of copper, nickel, tin, lead, and zinc and to the larger quantities of scrap metals.

The value of the secondary platinum, iridium, and palladium recovered in 1923 amounted to about $5,590,000, which was about 53 per cent of the value of the platinum and allied metals imported for consumption in the United States during the year.

The value of the gold and silver contained in old jewelry, dental waste, silver spoons, tableware, ornaments, and other articles remelted or refined in 1923 was $34,804,770. Mints and refineries reported the recovery of 8,469,806 fine ounces of silver and 1,416,375 fine ounces of gold from waste or discarded material. Jewelry and dental waste furnish the largest supplies of secondary gold, and silverware and photographic waste of secondary silver. The recoveries of silver from waste film and from photographic solutions probably amounted to more than 900,000 ounces.

Most of the silver recovered from photographic waste is obtained from solutions and is recovered by the larger makers of films and plates and by the moving-picture industry. Generally these solutions contain less than half an ounce of silver to the gallon. The recovery from waste film is probably 800 ounces to the million feet.[2]

It is difficult to estimate the value of ferrous scrap remelted in 1923. Estimates of the quantity range from 7,000,000 to 10,000,000 long tons. Estimates can be obtained for scrap iron and steel used at smelting plants, but no data are available for the large quantities of scrap iron used at the thousands of foundries, some of which use as high as 30 to 40 per cent of scrap material.

A considerable part of the scrap ferrous metal contained nickel, tungsten, manganese, chromium, vanadium, molybdenum, or other alloy metals, which made it much more valuable than the ordinary commercial iron and steel scrap, though the market is limited, and some knowledge regarding consumers is necessary to locate prospective purchasers. The railways are, on the whole, the largest producers of most kinds of metal scrap, as well as the largest users of new and remelted metal. It is estimated that the railways usually supply more than 40 per cent of the scrap iron and steel.

An article in the Waste Trade Journal, April 26, 1924, page 3, entitled "The scrap-iron dealer," gives some idea of the importance and vast scope of the scrap iron and steel industry. In this article the estimated quantity of old scrap iron and steel used in 1923 is given as 11,000,000 to 13,000,000 tons.

It is impracticable and unnecessary to segregate the statistics relating to the melting, refining, and use of secondary metals according to States. Nearly all the secondary aluminum was reported from Ohio, Michigan, Connecticut, Illinois, Pennsylvania, and Missouri. The largest recoveries from tin dross, tin scruff, and clean tin scrap were made in Pennsylvania, New York, New Jersey, Ohio, and West Virginia. Nearly all the secondary nickel was reported from Connecticut, New Jersey, New York, and Illinois. The recoveries of lead, zinc, and copper and of such alloys as babbitt, bronze, brass, and pewter were more generally distributed, though the largest secondary smelters and refineries are in Pennsylvania, Illinois, Missouri, Michigan, Ohio, New York, and New Jersey.

[2] Byers, C. A., Recovery of silver from movies' laboratory waste: Eng. and Min. Jour.-Press, Aug. 26, 1922, p. 373.

Secondary metals of certain classes recovered in the United States in 1922 and 1923

	1922		1923	
	Short tons	Value	Short tons	Value
Copper, including that in alloys other than brass	144,100	$38,907,000	193,200	$56,800,800
Brass scrap remelted	274,000	58,100,000	311,000	72,843,800
Lead as metal	75,480	17,551,600	96,430	27,228,600
Lead in alloys	84,080		98,060	
Zinc as metal	69,314	9,070,300	65,210	10,042,200
Zinc in alloys other than brass and in chemical compounds	10,250		8,630	
Tin as metal	6,570	12,443,500	7,892	25,316,000
Tin in alloys	12,940		22,318	
Antimony as metal	182	765,700	245	1,252,800
Antimony in alloys	6,908		7,776	
Aluminum as metal	7,190	6,085,900	6,800	10,824,600
Aluminum in alloys	9,100		14,500	
Nickel as metal	104	967,700	177	1,109,800
Nickel in nonferrous alloys	1,408		1,373	
		143,891,700		205,418,600

SECONDARY COPPER

Secondary copper recovered in 1923, with imports and exports of brass and copper scrap

	Short tons
Copper as metal	141,300
Copper in alloys other than brass	51,900
	193,200
Copper from new scrap (not including brass)	35,000
Copper from old scrap (not including brass)	158,200
	193,200
Brass scrap remelted:	
New clean scrap	150,000
Old scrap	161,000
	311,000
Copper content of brass scrap (averaging 70 per cent copper):	
New scrap	105,000
Old scrap	112,700
	217,700
Total secondary copper (including copper content of brass scrap):	
From new scrap	140,000
From old scrap	270,900
	410,900
Brass scrap imported	20,395
Scrap copper imported	2,743
Brass scrap exported	6,587
Scrap copper exported	1,772

Of the total quantity of secondary copper recovered in 1923, 65,719 tons (7,286 tons less than in 1922) was recovered by plants refining primary metals and the remainder by plants treating only secondary materials. The copper produced by smelters of secondary material included 75,581 tons of pig copper, 51,900 tons of copper in alloys other than brass, and 217,700 tons of copper in remelted brass. These figures indicate increases of 35,186 tons in pig copper, 21,200 tons in alloys other than brass, and 25,900 tons in brass.

The value of the copper, both as metal and in alloys, computed at 14.7 cents a pound, the average price for the year of all marketable grades of new metal, amounted to $120,804,600.

According to the Bureau of Foreign and Domestic Commerce the exports of scrap copper and brass in 1923 increased 3,812 tons, and the imports decreased 59,499 tons, or approximately to the quantity imported in 1921. Railways sell or turn in the larger portion of their brass and copper scrap and other metal waste to dealers in part payment for new material, but the reports show that the railways utilized in their own shops and foundries more than 6,200 tons of brass in addition to 1,600 tons of copper and 8,700 tons of copper in alloys other than brass. The railway reports, however, frequently include under "brass" alloys that should more properly be designated "bronze." On the other hand, manganese bronze should be called manganese brass,[3] and scrap metals can be successfully employed in making it. It is probable that the increase of 21,200 tons of copper in alloys other than brass was due largely to a better separation of copper alloys.

The names recommended by the American Society for Testing Materials to be used in connection with certain brass, bronze, and nickel alloys of copper are given in the report on secondary metals in Mineral Resources for 1919.

The bulk of the domestic brass scrap accumulated during the World War has passed into consumers' hands or into dealers' storage bins, so that most of the war scrap has ceased to have any serious effect on the domestic scrap-metal market. The shipments of brass scrap to the United States, which in 1922 were very much greater than in normal years, decreased from 71,962 tons in 1922 to 20,395 tons in 1923. It is very probable that most of the war scrap in Europe has reached dealers or consumers.

Every brass-manufacturing plant has the problem of scrap material to face. The Brass World of September, 1923, page 304, has a brief but comprehensive article on such problems, entitled "How to meet the scrap or waste problem in the manufacture of brass goods."

S. Skowvonski, metallurgist of the Raritan Copper Co., in a recent speech said that there was undoubtedly room for considerable increase in the use of scrap in the production of copper alloys. If scrap metal is clean it is an advantage rather than a detriment in remelting, and it is perfectly good practice to use as much as 90 per cent scrap in the total melting. He also estimated that nearly 75 per cent of fabricated copper in everyday use eventually returns to be consumed in the form of scrap.

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[3] Livermore, F. A., Manganese bronze—the use of scrap: Brass World, February, 1923, pp. 43–44.

SECONDARY LEAD

Secondary lead recovered in 1923, in short tons

Secondary lead recovered by smelters that treat mainly ore	36,604	
Secondary lead recovered by smelters that treat only scrap and drosses	59,826	
		96,430
Secondary lead recovered in remelted alloys:		
Lead content of antimonial lead scrap treated at regular lead smelters	2,594	
Lead content of drosses and scrap alloys treated at secondary smelters	95,466	
		98,060
Total secondary lead recovered		194,490

Refined primary lead produced in the United States in 1923, in short tons

From domestic ore	543,841
From foreign ore and base bullion	74,481
Lead content of antimonial lead from foreign and domestic ores treated at regular smelters	12,020

The secondary lead recovered in 1923 amounted to about 22 per cent more than in 1922. The secondary lead recovered as pig lead increased 20,950 tons, and the secondary pig lead recovered by those smelters whose product is mainly primary metal increased 9,556 tons. The quantity of secondary lead recovered in alloys increased 13,980 tons. A considerable part of the lead recovered from alloys was derived from old babbitt metal, solder, type metal, and white-metal drosses, but the main sources of secondary pig lead are old pipe, lead cable, battery plates, and lead lining of acid tanks. Regular primary smelters reported the recovery of 2,594 tons of lead in scrap antimonial lead, or 2,135 tons more than in 1922. About 3,677 short tons of lead in shrapnel and type metal was imported under the classification of type metal in 1923, a fifth of that imported in 1922.

The use of lead in batteries has expanded rapidly with the growth of the automotive industry, and a very large part of the secondary lead now recovered is obtained from old batteries.

The total output of secondary lead was equal to about 31 per cent of the refined primary lead produced in the United States in 1923, compared with 30 per cent in 1922. It was not exceeded by the output of primary domestic lead in any one State.

SECONDARY ZINC

Secondary zinc recovered in 1923 and products made from zinc dross, skimmings, and ashes, in short tons

Secondary zinc recovered by redistillation	39,434	
Secondary zinc recovered by sweating, remelting, etc	25,776	
		65,210
Zinc recovered in alloys other than brass		8,630
Zinc recovered in brass (estimated)		65,000
Zinc dust made from zinc dross		4,402

Zinc dross used for zinc dust (estimated)	5,136
Zinc dross, concentrates, and ore exported	14,745
Lithopone made from zinc skimmings and ashes	43,902
Secondary zinc content of lithopone	8,723
Zinc chloride made from zinc skimmings, ashes, etc.	43,089
Zinc content of zinc chloride made from zinc skimmings, etc	9,478
Zinc content of zinc sulphate made from zinc skimmings, ashes, etc	1,241

Zinc was the only secondary metal that showed a decrease in the total quantity recovered in 1923, but more zinc dross was exported in 1923 than in 1922, and more lithopone and zinc dust was made from dross, skimmings, etc., than in 1922. The estimated zinc content of brass remelted in 1923 increased 4,720 tons over that in 1922.

The recovery of secondary zinc (including that in brass) in 1923 was 27 per cent of the output of primary zinc in the United States. This recovery was about 1,000 tons less than in 1922, but there was an increased use of zinc dross, ashes, and skimmings for lithopone, zinc chloride, and zinc dust, which reduced the quantity of these materials available for sweating and redistillation. The quantity of galvanized sheets and forms made in 1923 was 1,129,734 long tons, or almost 114,000 long tons more than in 1922.

Five smelters—one each in New Jersey, New York, Ohio, West Virginia, and Pennsylvania—treated zinc drosses and skimmings by means of large graphite retorts of 600 to 800 pounds capacity instead of the small clay retorts used by smelters treating ore or mixed ore and drosses. The many uses of zinc drosses and skimmings create active competition for their purchase. Considerable zinc is recovered by sweating, and the residues are then sold for redistillation.

The production of zinc from drosses and skimmings made by smelters by redistillation was 6,446 tons more in 1923 than in 1922.

The zinc recovered in alloys other than brass amounted to 8,630 tons, compared with 10,250 tons in 1922. Of the secondary zinc recovered unalloyed 60.5 per cent was obtained by redistillation from drosses and skimmings and the remainder by sweating and remelting. In addition to the 65,210 tons of remelted and redistilled zinc, 43,902 tons out of a total production of 110,849 tons of the zinc pigment lithopone (containing approximately 30 per cent sulphide and oxide) was made from zinc skimmings and ashes. It is estimated that the zinc content of skimmings and ashes used for lithopone was 8,723 tons, an increase of about 2,600 tons. The quantity of zinc chloride made in 1923 was 49,411 short tons, of which 43,089 tons, containing 9,478 tons of zinc, was made from zinc ashes and skimmings. The secondary zinc recovered in all zinc pigments in 1923, including that in lithopone, was 10,322 short tons, and that recovered in zinc sulphate 1,241 short tons. The exports of zinc drosses, which amount to 5,123 tons in 1919, 2,445 tons in 1920, 510 tons in 1921, and 8,412 tons in 1922, were not separately recorded in the Department of Commerce for 1923. The zinc recovered in brass increased from about 60,280 tons in 1922 to 65,000 tons in 1923.

Two plants in San Francisco are making zinc dust from zinc dross, so that all that material available on the Pacific coast has a good

market; but none of the secondary plants on the Pacific coast treat zinc ashes or skimmings, and it is necessary to ship them to eastern plants for treatment. About 5,136 tons of dross was used in the United States in 1923 to make 4,402 tons of zinc dust.

SECONDARY ANTIMONY

The production of secondary antimony in 1923, of which all but 245 tons was recovered in alloys, amounted to 8,021 tons, an increase of about 13 per cent. The value given in the table on page 267 is based on the average yearly price for ordinary brands of antimony as published by the American Metal Market. The regular smelters reported the recovery of 478 tons of antimony contained in 3,072 tons of antimonial lead scrap. The recovery from secondary sources was equal to about 73 per cent of the imports. The principal materials refined or resmelted that contained antimony as an alloy were hard-lead drosses, babbitt, battery plates, solder, pewter, and type metal. Antimony used in the rubber, glass, enamel, paint, and ceramic industries does not yield any secondary recoveries. The quantity of antimony used for coloring rubber and for pigments has materially increased owing to the increased price of quicksilver.

No production of antimony from domestic antimony ore was reported in 1922. There was 14,190 short tons of primary antimonial lead, which contained 2,170 tons of antimony, recovered at the smelters. Of the 14,190 tons of antimonial lead, 11,635 tons was produced from domestic ores. The antimony imported in ore, as metal, or as oxide or salts amounted to 10,922 tons.

SECONDARY TIN

Secondary tin recovered in 1923

Tin recovered as pig tin	short tons	7,892
Tin recovered in alloys and chemical compounds	do	22,318
		30,210
Clean tin-plate scrap treated	long tons	162,732
Old tin-coated containers treated	do	262
Metallic tin recovered at detinning plants	pounds	1,871,600
Tin content of tin tetrachloride, tin bichloride, and tin oxide made at detinning plants	pounds	3,962,500
Total tin recovered at detinning plants	do	5,834,100
Tin tetrachloride, tin bichloride, and tin oxide made at detinning plants	pounds	7,939,917
Average quantity of tin recovered per long ton of old tin coated containers	pounds	22.4
Average quantity of tin recovered per long ton of clean tin-plate scrap	pounds	35.85

Tin and tin concentrates imported and tin produced from imported concentrates in 1923

Tin imported as metal for consumption	short tons	77,166
Tin concentrates imported	do	3,015
Tin produced from foreign concentrates smelted in the United States	short tons	7,466

The United States consumes more than 50 per cent of the world's output of tin, but apparently no metallic tin was derived from domestic mines in 1923, though a few tons of tin concentrates were recovered from Alaska placers.

The secondary tin recovered increased from 19,510 tons, valued at $12,443,500, in 1922 to 30,210 tons, valued at $25,316,000, in 1923, equal to about 36 per cent of the tin imported as pig metal and smelted from foreign concentrates in the United States during the year (84,632 short tons). The value of the recovered tin here assigned is arbitrary and is based on the yearly average price (41.9 cents) for 99 per cent metal, with prompt delivery at New York, given by the American Metal Market. The secondary tin in alloys increased 9,378 tons, and the secondary pig tin increased 1,322 tons.

Nearly all clean tin-plate scrap is detinned by the electrolytic alkali process, the chlorine process, or the alkali saltpeter process.[4]

The tin reported recovered in alloys and compounds included the tin content of products made in several plants from clean tin-plate scrap and old tin-coated cans. The materials recovered included some tin crystals, tin oxide, and putty powder but consisted mainly of tin tetrachloride and tin bichloride. The production of these compounds is stated together, in order to avoid disclosing confidential information. As the products are made from scrap tin and thus conserve the primary metal, they are properly regarded as recovered tin.

The largest recoveries of tin were made from the scruff and drosses that occur in making tin plate and terneplate and amounted to about 6,600 tons. The quantity of tin plate and terneplate made in 1923 was about 1,507,000 long tons, or nearly 220,000 long tons more than in 1922.

About 2,914 short tons of tin was recovered from clean scrap tin plate, either as pig tin or as tin chloride, tin crystals, or tin oxide. Apparently only about 400 tons of pig tin was recovered from scrap tin (not tin plate), clippings, old tin pipe, tin foil, and collapsible tubes, and it is impossible to give separately the quantities of tin recovered from these sources. Old block-tin pipe is most acceptable scrap, but the quantity available is small and is steadily declining. A considerable quantity of tin was also recovered from waste tin liquors used in dyeing.

Nearly all the tin-plate scrap imported in 1923 came from Canada. A comparatively small quantity of old tin containers was used to make sash weights by remelting in a cupola. No tin was recovered from this process, and the impure metal recovered is not suitable for ordinary castings, being too brittle. An investigation conducted by the Bureau of Mines showed that in an electric furnace detinning the scrap was impracticable, though synthetic cast iron made from tin-plate scrap was used successfully in making castings of good quality. A small portion of the clean tin strips cut from sheets is sold to makers of boxes and baskets and is used to bind, strengthen, or fasten the tops of the containers made.

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[4] A short history of the detinning industry: Met. and Chem. Eng., August, 1917, pp. 187–189.

A large quantity of tin was recovered in bronze, and part of the brass remelted contains a little tin and lead, which in the aggregate amounts to a considerable quantity. Other alloys from which secondary tin was recovered were solder, babbitt, pewter, terne metal, and electrotype metal.

From reports received by the Geological Survey the clean tin-plate scrap detinned in 1923 was about 28,460 long tons more than in 1922. The average metallic content of the tin oxide was given as 65.8 per cent, that of the tin bichloride as 24.5 per cent, tin crystals 52.6 per cent, and tin tetrachloride between 45.4 and 46 per cent.

The relatively small quantity of secondary tin recovered from tin-plate scrap and old tin-coated cans is significantly shown when compared with the quantity of tin used in making tin plate. It is estimated that 35,000 short tons of tin was used by makers of tin plate in 1923, that the total recovery of tin as metal and in compounds from tin-plate scrap and old cans was 2,917 short tons, and that of this quantity only about 3 tons was obtained from old cans.

All the old cans detinned in 1923 were treated by the Vulcan Detinning Co. The cans purchased were classified as follows:

Class 1. Unused empty and unrusted tin cans not exceeding the 1-gallon size, with or without labels attached but otherwise free from foreign material such as ice, water, ashes, paint, varnish, white lead, and similar insoluble (in water) contents.

Class 2. Used cans not exceeding the 1-gallon size and otherwise as described in class 1.

Class 3. Used empty and unrusted tin cans exceeding in size the 1-gallon size but not exceeding the 5-gallon size and otherwise as described in class 1.

A description of the method used in treating old tin-coated cans is given in Mineral Resources for 1919.

New tin-plate clippings were treated at plants of the Vulcan Detinning Co. at Sewaren, N. J., Neville Island, Pa., and Streator, Ill.; by the Johnson & Jennings Co., of Cleveland, Ohio; and at the plants of the Metal & Thermit Co. at San Francisco, East Chicago, Ind., and Chrome, N. J.

The plants utilizing old tin cans, which can handle 25,000 tons a year, treated only 262 long tons in 1923. These plants have never received shipments large enough to operate steadily at full capacity, even when the prices of tin and black sheet-metal scrap were high. The present prices do not warrant even local collections of old cans, and the plants are practically idle. The supply of tin chloride, which is made almost entirely from scrap and which is the main product of detinning plants, is ample since war uses have ceased.

Although there is now a supply of tin sufficient for all requirements at less than pre-war prices, there are two good reasons for restricting its use to the lowest point. One is that the supply of new tin is derived almost entirely from foreign sources, and the other is that tin is a relatively high-priced metal and the use of substitutes giving approximately equal efficiency radically reduces the cost of many alloys, such as solder, babbitt, and other bearing metals.

SECONDARY ALUMINUM

Secondary aluminum recovered in 1923, in short tons

Secondary aluminum recovered unalloyed	6,800
Aluminum recovered in alloys (mainly No. 12)	14,500
	21,300

Primary aluminum produced, imported, and exported in 1923

Value of primary aluminum produced in the United States	$28,305,000
Aluminum (crude and semicrude) imported for consumption—pounds	42,476,789
Aluminum (crude and semicrude) exported—pounds	5,539,671

The recovery of secondary aluminum as pig aluminum or in alloys in 1923 amounted to 21,300 short tons, valued at $10,824,600, compared with 16,290 tons, valued at $6,085,900, in 1922.

Some of the larger secondary smelters and refiners of aluminum in 1923 were as follows:

Peninsular Smelting & Refining Co., Detroit, Mich.
Michigan Smelting & Refining Co., Detroit, Mich.
United Smelting & Aluminum Co., New Haven, Conn.
United States Reduction Co., East Chicago, Ind.
United States Aluminum Co., Pittsburgh, Pa.
Great Western Smelting & Refining Co., St. Louis, Mo.
Cleveland Electro Metals Co., Cleveland, Ohio.
Loewenthal Co., Chicago, Ill.
National Smelting Corporation, Cleveland, Ohio.
Charles L. Hilb Smelting & Refining Co., Cincinnati, Ohio.
Columbia Smelting & Refining Co., New York, N. Y.
W. F. Jobbins Co. (Inc.), Aurora, Ill.
Apex Smelting Co., Chicago, Ill.
General Aluminum & Brass Corporation, Detroit, Mich.
General Metal Refining Co., St. Louis, Mo.

Various products are made by smelters and refiners from scrap aluminum.

A large quantity of No. 12 secondary ingots (92 per cent aluminum and about 8 per cent copper) is made by smelters from old or defective castings, borings, and scrap, as is shown by the fact that the secondary recovery of aluminum in alloys was 68 per cent of the total recovery in 1923. The expanded output of the automotive industry, which is estimated to consume more than 25 per cent of the aluminum production, is reflected in the increased consumption of secondary No. 12 alloy. The recovery of aluminum in alloys in 1923 was 60 per cent more than that reported in 1922. The recent articles relating to aluminum are as follows:

Anderson, R. J., Iron-pot melting practice for aluminum alloys: Metal Industry, February, 1922, p. 60.

Notes on aluminum alloys for casting, prepared by the technical department, Aluminum Co. of America: Chem. and Met. Eng., Sept. 6, 1922, p. 501.

Lange, J. A., Melting aluminum for rolling; Brass World, vol. 19, p. 272, August, 1923.

The following articles on aluminum were published in the report for 1919 on secondary metals:

Casting losses in aluminum foundry practice in the United States, by Robert J. Anderson.
Scrap aluminum, by Charles Vickers.
Tentative specifications for aluminum presented to the American Society for Testing Materials.

SECONDARY NICKEL

Secondary nickel recovered in 1923, in short tons

Nickel recovered as metal	177
Nickel recovered in nonferrous alloys and salts	1,373
	1,550

Primary nickel produced, imported, and exported in 1923, in short tons

Nickel produced as a by-product from the electrolytic refining of copper at domestic refineries	100
Nickel imported for consumption in the United States as nickel or in nickel ores and matte, oxide, and alloys	20,335
Nickel oxide and matte exported	6
Nickel, monel metal, and alloys exported	434

The nickel recovered from secondary sources in 1923 includes nickel in monel metal but not in ferrous alloys. Most of the nickel in matte, oxide, ore, etc., imported came from the Sudbury district, Ontario. No nickel was recovered at the refinery of the Missouri Cobalt Co., at Fredericktown, Mo., from ores that contain nickel, lead, copper, and cobalt, and the only production from domestic sources was obtained from the electrolytic refining of copper.

The secondary metal recovered from nonferrous sources in 1923 was equal to 7.6 per cent of the imports. It was equal to 20 per cent in 1922, owing to the unusually small imports.

Formerly more than 60 per cent of the refined nickel produced was used in nickel steel, 30 per cent in white-metal alloys, 5 per cent in anodes for plating, and 5 per cent for miscellaneous purposes, including the manufacture of salts and other chemical compounds. Since the World War, however, much less nickel is used in ferrous alloys. The International Nickel Co. states that the sales in 1923 indicate that approximately 40 per cent was used in ferrous alloys, 16 per cent in nickel silver, 26 per cent in anodes, 11 per cent in special alloys, including nichrome, and 7 per cent for miscellaneous purposes.

As nickel is used chiefly as an alloy in steel, and as the secondary nickel reported to the Geological Survey as recovered in 1923 was obtained solely from nonferrous scrap, it is evident that the 1,550 tons of nickel reported forms only a portion of the nickel in alloys recovered and reused.

An article written by J. A. Wadhams entitled "Nickel, monel, since the war," quoted in the Brass World, May, 1924, discusses the development in the nickel industry due to the necessary change from an almost purely ordnance industry to that of peaceful arts. Gun forgings, armor plates, bayonet steel, and bullet jackets formerly con-

sumed the bulk of the nickel produced. A critical survey now shows that the use of nickel steel for automobile construction and for general machinery and equipment is steadily expanding. Nickel is also being more generally used instead of brass, bronze, and silver-plated alloys in dairy, laundry, cafeteria, and household equipment and utensils. For this reason it is certain that the quantity of secondary nickel recovered will greatly increase in a few years.

In both the printed annual report of the International Nickel Co. for 1923 and in its publication Inco special attention is drawn to the intensive research for and development of new uses for nickel, monel metal, and other nickel alloys. Research and advertising are bringing successful results which will more than compensate for the losses sustained by the reduction of armaments and ordnance.

The secondary nickel reported in 1923 was nearly all recovered from old nickel anodes, nichrome, nickel silver, and monel metal. A nickel alloy which is now being more generally used is composed of about 60 per cent nickel and the remainder mainly chromium. The properties and uses of this alloy, called "nichrome," which is used in heat treatment of steel, are described in an article recently published.[4] Extracts from this article are given in the report on secondary metals in 1919.

Analyses of various nickel alloys have already been published by the United States Geological Survey.[5]

The International Nickel Co., desiring to assist users of monel metal to dispose of scrap and at the same time to protect the purity of the primary metal, has established a definite procedure in the purchase of monel scrap. The company's publication Inco contains the following information:

> The mining and smelting operations are located at Copper Cliff, Ontario; the refining and rolling operations are located at Port Colborne, Ontario, and Huntington, W. Va. Monel-metal scrap must enter operations at one of these points. This is decided to a large extent by the purity of the scrap.
>
> Monel metal as produced is held to a close chemical specification. It contains approximately 67 per cent of nickel, 28 per cent of copper, and 5 per cent of other elements. It has in it no lead and no zinc.
>
> If the user has not allowed other materials to become mixed with his scrap it should meet production specification. However, it is not entirely possible to prevent all contamination, and in the purchase of scrap the International Nickel Co. allows a certain tolerance. Therefore, scrap within the analysis given below will be purchased at a flat price, which will be quoted on receipt of detailed description of the scrap offered from time to time by the consumer.
>
> Nickel, not less than 64 per cent; copper, not less than 27 per cent; iron, not more than 3½ per cent; sulphur, not more than 0.05 per cent; lead, none; zinc, none.
>
> Providing such scrap does not come within the above analysis, settlement will be made on a basis of copper-nickel content, the price of which will be quoted after sampling and analysis by the International Nickel Co. All scrap will be purchased and settled for on a basis of weight, sample, and analysis.
>
> The cost of sampling and analyzing a shipment of scrap is approximately $35. It is therefore necessary to avoid handling small shipments of scrap, if possible, and all consumers are requested to collect their scrap until they have at least 500 pounds before offering it for sale.

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[4] Equipment for foundry and plating room: Brass World, vol. 16, pp. 146–147, May, 1920.

[5] Hess, F. L., Nickel: U. S. Geol. Survey Mineral Resources, 1915, pt. 1, pp. 763–765, 1917.

ANTIMONY

By Frank C. Schrader

THE ANTIMONY SITUATION

The United States is dependent upon three main classes of material as sources of antimony or its alloys or compounds—metallic antimony, liquated antimony sulphide, and antimony ore. Metallic antimony, known as antimony regulus, is imported from China, Japan, Mexico, and other countries and during the World War was produced in small quantity in the United States from both foreign and domestic ores. The metallic antimony imported from Japan is derived mainly from the refining of Chinese ore or "crude." Liquated antimony sulphide, also known as "crude antimony," "needle antimony," and antimony matte, is imported in small quantity from China. This material is produced by submitting the ores of the natural antimony sulphide, stibnite, to a heat sufficient to melt but not to decompose it, and the molten metallic sulphide is then run into molds and allowed to cool. Antimony ore is imported from China (direct or by way of Japan), Bolivia (by way of Chile and Peru), Mexico, and other countries, and small quantities of ore are at times produced in the western United States.

A fourth class of material which should also be mentioned is antimonial lead, carrying from 12 to 18 per cent of antimony. Any of the three classes of materials noted above may enter into this product, but it is derived mainly from lead ores, most of them of the antimonial variety.

The United States has always been dependent mainly on foreign sources for its supplies of antimony. China and Japan have been the principal contributors, although Mexico and Bolivia have also made considerable contributions. This dependence is in part a reflection of the higher wage scale in this country as compared with certain foreign countries, particularly China, but it is due primarily to our comparative poverty in antimony resources. However, little information of a quantitative nature has been collected concerning these resources, and they may be somewhat greater than has generally been assumed.

The examination in 1919 of a few of the deposits in Lander County, Nev., and in 1923 of deposits in Valley County, Idaho, indicates the presence of moderate reserves of ore at those localities. Newly discovered deposits are reported to occur in Camas County, Idaho, and in Tulare County, Calif.

Antimony is a minor metal. Its market is widely recognized as one of the most unstable of the metal markets. The world's requirements for antimony are comparatively small, and when an extra quantity is thrown upon the market prices react sharply, the trade becomes so cautious that the market may disappear altogether, and production rapidly falls off.

The antimony market during the pre-war and war periods.—For many years prior to the World War the New York prices of the ordinary grades[2] of metallic antimony ranged from 6 to 8 cents a pound. The average yearly quoted price from 1909 to 1913, inclusive, did not fall below 7.27 cents (1910), and the highest price during the period, 7.63 cents, was established in 1912. The lowest average monthly level during the same period, 6.05 cents, was established in December, 1913.[3]

The imports, calculated as antimony metal, formerly ranged from about 4,000 to 7,500 short tons, and the production from ores mined in this country was negligible. On the outbreak of the World War, during which at least 12 countries mined antimonial ore to the full extent of their productive capacity under war conditions, the price of antimony began to rise rapidly because of the need of the metal in the manufacture of shrapnel bullets, and as uncertainty was felt in regard to the continuance of supplies from abroad, numerous mines in the Western States and several in Alaska were put into operation. By the end of 1915 the New York price had reached 40 cents a pound, and by March, 1916, it attained its maximum, for ordinary grades, of about 45 cents. These high prices drew out in the United States in 1915 a production of ore carrying about 2,100 short tons of antimony and in 1916 ore containing about 1,770 short tons of antimony. The high prices also greatly stimulated imports, and this forced down the prices of ordinary grades to 11 cents a pound late in 1916 and made it impossible for most of the new domestic mines to operate at a profit. By the end of 1916 many of these mines had closed and others were in a precarious condition.

In anticipation of the entrance of the United States into the war there was a noticeable recovery in prices, ordinary grades reaching about 35 cents in April, 1917. This increase again stimulated imports, which proved to be far in excess of the demands and not only forced a rapid decline in price to a fairly constant level of about 15 cents during the last half of 1917 but also built up large stocks in bonded warehouses (see fig. 12) and in the hands of dealers and consumers. Stocks in bonded warehouses alone, which were negligible in the early part of 1917, amounted to more than 10,000,000 pounds at the end of the year. The decline in prices in 1917 dealt a heavy blow to domestic antimony mining, which during the year produced ore carrying only about 390 short tons of metallic antimony. Before the end of the year nearly all domestic mines had ceased operation.

In 1918 the prices of antimony did not show the extreme fluctuations of the three preceding years. As the large stocks on hand at the beginning of the year were absorbed, imports increased. In January the price was 14.23 cents a pound; this decreased gradually

[2] By "ordinary grades" was understood formerly Hungarian and French brands; more recently the term has been applied to Chinese and Japanese brands.

[3] Metal Statistics, American Metal Market, 1923.

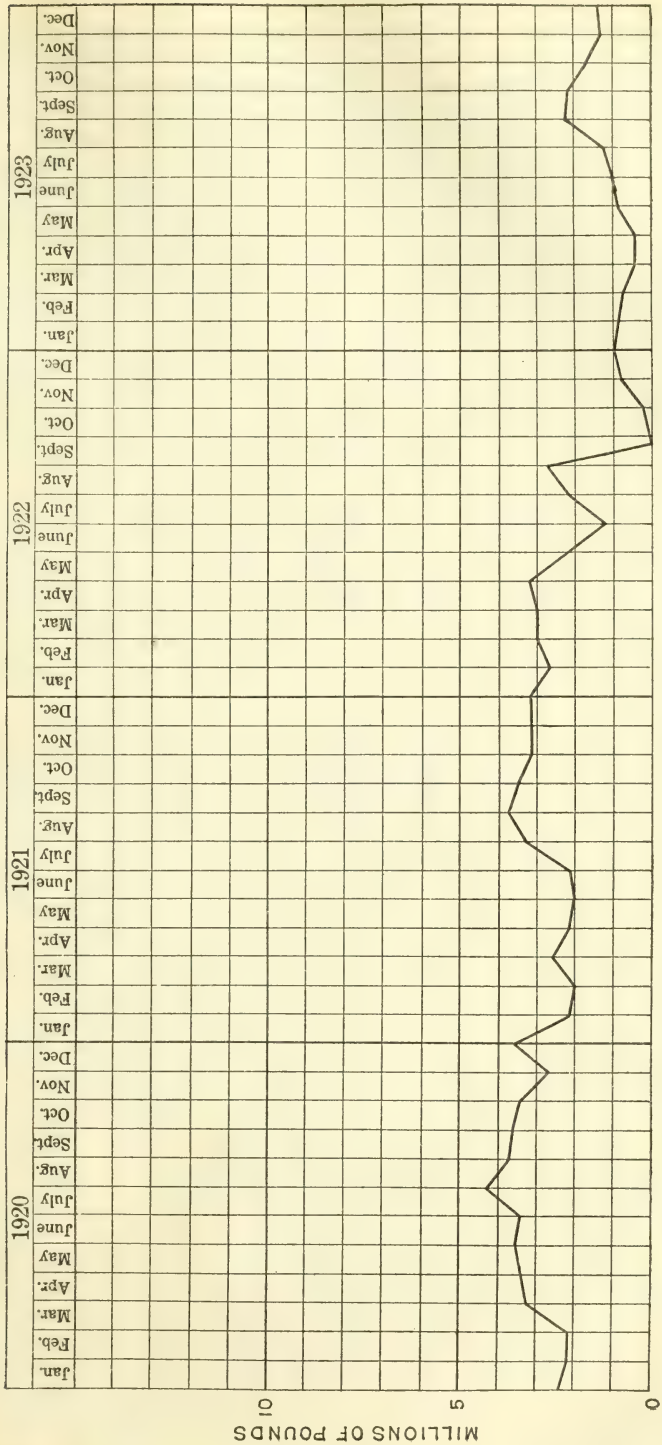

FIGURE 12.—Stocks of metallic antimony in bonded warehouses at end of each month, 1920–1923

to 12.41 cents in May and then rose to nearly 14 cents a pound in September. As antimony was used in large quantities for war purposes, the declaration of the armistice brought a sharp drop in price. For the week ending October 26 the average price quoted by the American Metal Market was about 13⅜ to 13½ cents a pound. The following week prices fell off about 1 cent. On November 9 the price quoted was about 9½ to 11 cents, and on November 16, 8¾ cents. Prices fell to about 7⅝ cents a pound at the end of the year, and stocks in bonded warehouses amounted to about 5,000,000 pounds, or about half what they were at the beginning of the year.

Domestic producers could not make a profit at the prices prevailing in 1918, and only about 190 tons of ore, containing about 50 tons of antimony, was mined. The mines have remained practically idle since early in 1918. The antimony smelters continued production from imported ores until November, 1918, when all production of metallic antimony was temporarily suspended. Two smelters made a small output from foreign ores in 1919 and one in 1920.

The sudden ending of hostilities found all the Allies holding large stocks of antimony, more than sufficient for a year's supply. In addition to these stocks there were large supplies of antimonial lead and other alloys available, and more was obtained by salvage.

The metallic antimony available in this country at the beginning of 1918 equaled a normal year's domestic consumption, and there was made available during that year from all sources 24,636 tons additional.

The antimony market, 1919–1922.—At the beginning of 1919 the antimony market was confronted with 5,056,368 pounds of antimony held by the United States Government in bonded warehouses pending liquidation, and the offer for sale by the Canadian Government of 3,000,000 pounds of the metal, together with large quantities of antimonial lead containing 2,400,000 pounds of antimony.[4] These sources alone amounted to more than 5,200 tons, which, together with large stocks in the hands of dealers and manufacturers of antimony alloys and type metal, probably also exceeded a year's domestic consumption. Notwithstanding this large surplus at the beginning of the year, there was imported during the year nearly 15,000,000 pounds, or 7,500 tons, of antimony, considerably more than an additional half year's consumption, with the result that prices continued to be forced downward. Also the stocks of shrapnel on hand in the different countries were sufficient as a reserve stock for possible future wars, should any occur before a substitute for antimony in shrapnel could be discovered. These unabsorbed supplies and the continuation of imports forced a decline in price, with the result that the average quoted price of antimony in 1919 was 8.16 cents a pound—almost as low as in 1913. This decline, together with increased cost of mining, further discouraged production. The prices continued low, but they were free from war-time fluctuations and more steady than for any of the preceding four years. They were confined to the limits of 6½ and 9⅝ cents, a total range of only 3⅛ cents. The price compared favorably with the price of 7.43 cents in 1913, and, together with

[4] Mineral Industry, 1919.

the growing steadiness in the market, it seemed to indicate that the antimony trade was approaching normal. In January, 1919, the markets everywhere were reported to be overstocked. The average price for the month was 7.59 cents, only about half of what it was in the same month of 1918. The lowest price for the year, 6½ cents, was reached late in March, and the highest price, 9⅝ cents, late in December.

During the year the United States Government's large war surplus stock was absorbed, and at the end of the year the stock left throughout the country was low. Stocks in bonded warehouses amounted to 2,404,904 pounds, or about half of what they were at the beginning of the year. Most of the producers of antimony ore reported that a price of 20 to 25 cents a pound for metal would be required to enable them to make a profit in mining antimony ore at the costs prevailing in 1918.

The average quoted price of antimony in 1920 was 8.38 cents a pound. From the strong opening at 9.75 cents in January the price steadily advanced to 11⅝ cents in February and remained there until early in March, when, owing to large imports, it began a decline that in general continued almost steadily through the rest of the year. Heavy offerings of war scrap and shrapnel by several governments in September and October sent the price down, and in December it fell to 5.2 cents, the lowest price recorded for antimony in more than six years and a decline from the beginning of the year of more than 46 per cent.

The antimony market in 1921 was very unsatisfactory. In the general downward movement of the metals antimony fell more than any other metal. As there had been a surplus of antimony ores for the entire world in 1919 and 1920, there was no reason to expect that prices of antimony would increase during 1921 unless there should be a greatly increased tariff imposed on antimony and antimony ores or new uses of considerable extent for antimony should be found. Other than the import duty of 10 per cent on antimony metal and 15 per cent on type metal, there were no restrictions on imports of antimony. At the beginning of 1921 the price of antimony was 30 per cent below that of the pre-war average and below the cost of production. The decline was attributed to slackness of the consuming trade, large war stocks, and the decline in the price of silver. The average quoted price of antimony in 1921 was 4.92 cents a pound, only 59 per cent of the price in 1920 (8.38 cents). The highest price recorded during the year, 6 cents, was reached in March, and the lowest, 4.45 cents, in September. From the strong opening of 5.2 cents in January the price, with some fluctuations, rose to 5½ cents toward the end of that month but soon declined to 5¼ cents and remained at approximately that figure through February and early March, partly because of the new low record in silver and heavy war stocks thrown on the market. Toward the middle of March it suddenly rose to 6 cents, it is said because of an expectation of increase in import duties. Owing to continued large shipments arriving from the Orient, notably China, with ample supplies already on hand, the price soon began to fall and declined almost steadily, with the result that the average price for April and May was approximately 5.2 cents. From June to

September, inclusive, it was 4.7 cents; the average for September was 4.53 cents. In October the price rose to 5⅛ cents, with the market strong. In November it steadily declined. Throughout December, with the market dull, it remained at about 4½ cents.

The antimony market in 1922 continued unsatisfactory. At the beginning of the year the price of antimony was 4½ cents a pound, or 0.7 cent less than at the beginning of 1921 and nearly 40 per cent below the average for the five years immediately preceding the war, and was much less than the cost of production in the United States. The further decline in price to a very low level early in the year was attributed to slackness of the consuming trade and to the fact that large war stocks, including scrap, still remained in the hands of dealers and consumers. It was believed, however, that the old stocks would be consumed during 1923, and as the consumption increased the outlook for antimony mining grew brighter. The average price in 1922 was 5.42 cents a pound, half a cent more than the average price in 1921 (4.92 cents). The highest price of the year, 7 cents, was reached in September, and the lowest, 4.15 cents, was reached in March. During the first quarter of the year the market was dull, and the range in price was only 0.35 cent, the decline being almost steady from 4½ cents in January to 4.15 cents at the middle of March. In April the market improved, and the price reached a maximum of 5⅛ cents. In May the price advanced about one-fourth of a cent, owing, it is said, to expectation of a higher rate of import duty. During June the price declined to 5 cents. In July holders of stocks built hopes of higher prices on a higher tariff, but the market was without special activity, owing in part to the fact that large shipments were due to arrive soon from the Orient. The average price for the month was 5.08 cents. During August and September the price rose from 5¼ to 7 cents. From early in October to December 30, with the market in general quiet, the price gradually receded to 6.30 cents.

The antimony market in 1923.—In 1923 the antimony market showed marked improvement. The average price was 7.81 cents a pound, as compared with 5.42 cents for 1922. The prices ranged between 6.25 cents early in January and 10.25 cents at the end of December. The monthly prices for the year appear in the accompanying table.

Monthly prices of ordinary brands of antimony at New York during 1923, in cents per pound [a]

Month	Maximum	Minimum	Average	Month	Maximum	Minimum	Average
January	7.125	6.25	6.81	August	7.875	7.50	7.67
February	7.75	7.125	7.20	September	7.70	7.50	7.52
March	9.00	7.75	8.75	October	8.75	7.625	7.82
April	8.875	7.75	8.38	November	9.25	8.8	9.03
May	7.75	7.00	7.43	December	10.25	8.75	9.18
June	7.00	6.625	6.84				
July	7.75	6.75	7.05				7.81

[a] American Metal Market.

With improved business conditions early in 1923, which developed a buying movement, the antimony outlook grew brighter, and the price of the metal gradually rose from 6.3 cents a pound early in

January to 9 cents by the middle of March. This advance is attributed in part to civil-war risk attending shipments in China, to the rise in silver to 68⅝ cents an ounce, the maximum for the year, to European buying, to China's holding back in offerings and shipments in expectation of receiving higher prices, and, particularly during February and March, to domestic speculative buying induced by an impression that antimony would share in the advances of the other nonferrous metals during those months. The advance, which was largely inflated, did not lead to any special effort by China to increase output. A little later, on account of lack of confidence on the part of consumers and offerings made with less reserve by Chinese shippers, also on account of easier tone in the markets for other metals, and because large war stocks of shrapnel and antimonial lead were still on hand, the price gradually declined from 8⅞ cents early in April to 6.8 cents in July. From this level, however, owing chiefly to interruption of communication with Hunan, China, and shortage of production there, by reason of civil war, the price rose to the peak of 10 cents by the end of the year. Other causes to which the rise is in part attributed are European buying and the low prices of 1922, which may have been so unremunerative to China as to have caused production to dwindle to a very low ebb, but the elements of cost in China are very obscure and difficult to ascertain even approximately. In July the general conditions of trade were not favorable for a rise in price. War stocks of shrapnel and antimonial lead were not yet exhausted, though their effect was diminishing. In the early part of August European buying and small reserves of available stocks carried the price to 7.875 cents, and for a time it remained steady at that point. During September consumption was only fair and stocks were ample for all requirements at prices of 7.50 to 7.70 cents. October witnessed considerable interest, with a net rise in price of slightly more than a cent. The advance continued in the early part of November till the price of 9.25 cents was reached. It was caused mainly by buying on the part of consumers and the report that operations including October bookings had been interrupted in Hunan by the civil war. The advance was checked by profit taking on resale parcels, and with slackening of the demand the price declined to 8.8 cents at the end of the month. The trend of the market during December was upward. Opening at 8.75 cents, the price advanced to 10 cents toward the end of the month. The advance was due mainly to interruption of mining operations in Hunan and the risk attending down-river shipments from there.

It was reported that war stocks and shrapnel had disappeared from the market by the end of the year, and owing to the large and steadily increasing consumption of the metal the outlook for the antimony industry is much more promising than it has been at any other time since the war, and accordingly the price of about 10 cents a pound for the metal will probably prevail for some time. Most owners of domestic deposits of antimony ore of good grade state that they can not mine the ore profitably unless the price of the metal is up to about 20 cents a pound. It is probable, however, that antimony mining could be undertaken if there was assurance that a price of 16 or 17 cents would be continued over a considerable period.

By the new process for refining antimonial lead, developed by H. Harris, of London, 99 per cent of the antimony content is recoverable from the lead in a form easily reduced to the metallic state.[5] Although use of this process will probably contribute to the world's output of metallic antimony, it is not likely to affect the United States materially, for this country has use for practically all the antimonial lead it produces.

USES

METAL

Antimony was much more extensively used at one time than it is now. It was brought into great prominence by the World War on account of the large demand for it in the manufacture of ammunition, particularly bullets and shrapnel, in which it is employed as a hardening agent. Its peace uses are many, but only a few require large quantities of the metal, and although its war-time production, as shown in Figure 13, amounted to nearly 82,000 metric tons a year, it yet remained a minor metal. Its field of uses, however, exclusive of the abnormal war demand, is widening, and the consumption is increasing.

Metallic antimony unalloyed has a few industrial uses. As a pigment in the form of fine powder, known as "antimony black" and "iron black," it is used for bronzing metals and plaster casts. For producing the appearance of polished steel on articles made of papier-mâché or pottery it is precipitated by the action of metallic zinc on an acid solution of antimony salts. The chief use of antimony is in alloy with other metals. Antimony is a standard constituent of white-metal alloys of low melting point, such as type metal, britannia metal, and stereotype metal. It alloys readily with most heavy metals, and the alloy is harder than either of the two pure metals. Most of these alloys possess the property of slight expansion on solidifying. The metals with which antimony is most commonly alloyed are lead, tin, and copper.

Type metal is an alloy of lead, antimony, tin, and copper; babbitt, antifriction, or bearing metal is usually an alloy of antimony, tin, and copper. The largest use is in babbitt metal, and the next largest in coffin trimmings, which are made of antimonial lead, as are also automobile flower vases. Britannia metal, also known as "white metal," is an alloy of antimony, tin, and copper, with some zinc and rarely small quantities of other metals. It is used in making cheap domestic tableware, teapots, and spoons. Antimony alloys find minor utilization in battery plates, toys, cable coverings, and siphon tops. Small quantities of antimony enter into certain brasses and aluminum alloys. Lead-antimony alloy, or "hard lead," is used in making acid-resisting valves. Recently it has been used also in casting metal taps, etc., in which the eutectic mixture of the two metals, 87 per cent lead and 13 per cent antimony, is used, as it gives the best results and presents the least difficulty due to shrinkage or segregation of the metal.[6] In alloy with tin, lead, cadmium, and bismuth, antimony is used in making fuse rods or blocks for use in temperature indicators for bearings.

[5] Mining and Metallurgy, April, 1924, p. 187; June, 1924, p. 299.
[6] Metal Industry, vol. 21, No. 11, p. 453, November, 1923.

OXIDES

The antimony oxides are used chiefly for making white enamel and glass, the oxides and sulphides as coloring agents and pigments, and the sulphides in vulcanizing rubber. The oxide is used also in proportions up to 1½ per cent in the manufacture of litharge. It is used in making colloidal products employed in medicine and surgery, in tanning, in the preparation of cosmetics, for the protection of plants, and for the impregnation of wood fabrics.

In making opaque white enamel and other sanitary ware, the tetraoxide (Sb_2O_4) is mainly used. For this purpose the antimony oxides are employed as a substitute for tin oxide. In the manufacture of glass the trioxide is mainly used as a coloring agent, as it is more fusible than the tetraoxide and does not impart opacity to the glass.

During the last few years use of the white oxide in paint has become extensive. The chief product, which is put out by Cookson & Co. in England, is known by the trade name "timonox." Large quantities of it are imported into this country by paint and varnish houses. An apparently similar oxide, known as "antox," is produced in considerable quantities in Australia. According to recent investigations of the Paint Manufacturers' Association of the United States, antimony oxide as a paint pigment compares favorably with the well-known pigments lithopone and titanox and is nontoxic.[7]

Recently antimony oxide recovered from fumes at the Selby smelter has been used in making a gray paint that promises to be an excellent substitute for lead paint on oil tanks, water tanks, and similar work. Antimony oxide mixes readily and smoothly with linseed oil, forming a coherent paint that is very satisfactorily applied. It is not much more expensive than zinc oxide.

Antimonate of lead containing an excess of lead oxide, known as "Naples yellow," is used in oil paints and in the glass and ceramic industries. Tartar emetic (double tartrate of antimony and potassium), antimony trioxide, and antimony fluoride are employed as mordants in dyeing. Tartar emetic and antimony trioxide are also employed medicinally, and tartar emetic is used in fixing tannin. Antimonate of soda is used in making enamel ware. In a new use of the oxide it is combined with alkaline zinc to produce imitations of antique silver finishes in art, such as the polychrome work of early days, also antique silver trimmings on furniture.[8]

SULPHIDES AND OTHER COMPOUNDS

The red sulphides of antimony are used in vulcanizing and coloring red rubber and also in paint pigments. The quantity used for these purposes has greatly increased in the last few years. Formerly the natural antimony trisulphide, stibnite, entered into the composition of safety matches or of the compound which was put on the match box. "Black antimony" or "sugar of antimony" (Sb_2S_3) is used in making furniture polish and varnish suitable for violins and similar articles. Pulverized antimony sulphide, or liquated stibnite,

[7] Gardner, H. A., Titanox, antimony oxide, and lithopone: Paint Mfrs. Assoc. Circ. 199, pp. 260–264, 1924.
[8] Metal Industry, vol. 21, No. 3, p. 107, March, 1923.

is almost universally used in the manufacture of fireworks and as a constituent of primers in shells and cartridges. It is also used in the charge of shells, to produce on explosion a dense white smoke, which is of service in range finding and as a screen in defensive warfare.

Antimony chloride ($SbCl_3$) is used in the preparation of fireproof and waterproof creosote, pitch, tar, and asphalt preservatives of fibrous materials, such as wood, paper, and textile fabrics.

Fluoride of antimony and soda is used as a mordant in dyeing textiles.

SUBSTITUTES

There are a number of other metals or materials which will harden lead and therefore can be used as a substitute for antimony in lead alloys, but antimony is cheaper than most of the substitutes, and as the antimony deposits of the world are abundant in proportion to the consumption of the ore, the course of industry seems more likely to develop new uses for antimony.

Of the 10 or more known substitutes for antimony, the best found in recent years is a combination of calcium and barium, said to be used with excellent results by the United Lead Co. in the hardening of lead.[9] The process is electrolytic, and calcium-barium-lead alloys are now made on an extensive scale.

Canadian investigators are reported to have found that a steel-jacketed bullet may be substituted for one of antimonial lead.

"Ulco" metal or "Ulco lead" is simply pig lead treated in an electric furnace with a small percentage of other material (as barium?), which produces a hardness in the lead superior to that imparted by antimony, but according to the United Lead Co. it makes the lead 10 per cent heavier, or too heavy for shrapnel metal, in which 12½ per cent of antimony is customarily used.

Bismuth may be used as a substitute for antimony, but its cost is much higher.

Tin oxide and other white oxides may be used as a substitute for antimony compounds in paint and in general wherever such compounds are used for coloring.

As excellent primers have been prepared from pure lead sulphide and pure iron sulphide, it is probable that other sulphides could, if necessary, be substituted for antimony sulphide as a constituent of primers in shells and cartridges.

DOMESTIC PRODUCTION

Mine production of antimony ores in the United States, 1915–1923, in short tons [a]

Year	Total	Antimony content	Year	Total	Antimony content
1915	5,000	2,100	1918	190	50
1916	4,500	1,770	1922	20	4
1917	1,060	390	1923	40	10

[a] Mine production negligible prior to 1915, and no production from 1919 to 1921.

[9] Chem. and Met. Eng., Dec. 28, 1921, p. 1181; Min. Mag. (London), vol. 26, p. 127, 1922.

Smelter production of metallic antimony in the United States, 1917–1918 [a]

Year	From domestic ores		From foreign ores		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1917	258	$106,812	2,182	$903,348	2,440	$1,010,160
1918	127	32,004	2,490	627,480	2,617	659,484

[a] Not recorded prior to 1917.

Only two smelters reported a small production (all from foreign ores) in 1919 and one in 1920, and the Survey is not at liberty to publish the figures. Besides the small quantity of metallic antimony, there was also produced from foreign and domestic ores a relatively large quantity of oxides and other salts, the figures for which the Survey is not at liberty to publish. There was no smelter production in 1921 to 1923.

SMELTER PRODUCTION OF ANTIMONIAL LEAD

By-product antimonial lead produced in the United States from both foreign and domestic ores, 1919–1923

Year	Short tons	Antimony content	
		Short tons	Value [a]
1919	13,874	1,943	$319,000
1920	12,535	2,033	345,000
1921	10,064	1,589	158,000
1922	8,075	1,441	156,000
1923	14,190	2,170	338,500

[a] Calculated on basis of average yearly price for ordinary brands of antimony as given by American Metal Market.

The value of antimonial lead is approximately $5 less per short ton than the value of the lead content plus the value of the antimony content.

RECOVERY OF SECONDARY ANTIMONY

During 1923 8,021 short tons of antimony, valued at $1,252,800, was recovered from old alloys, scrap, and dross. Nearly all of it (7,776 tons, or 97 per cent), was recovered in the form of alloys, and only 3 per cent (245 tons) as metallic antimony; 478 tons, or 6 per cent, was recovered from antimonial lead scrap treated at regular smelters, and 7,543 tons, or 94 per cent, was recovered as metal and in alloys reported by secondary smelters.

Secondary antimony and antimony content of secondary alloys recovered from old alloys, scrap, and dross in the United States, 1919-1923

Year	Short tons	Value [a]	Year	Short tons	Value [a]
1919	4,399	$717,900	1922	7,090	$765,700
1920	5,600	938,560	1923	8,021	1,252,800
1921	4,720	464,400			

[a] Calculated at average yearly price for ordinary brands of antimony as published by the American Metal Market.

The principal materials refined or resmelted that contained antimony as an alloy were hard-lead drosses, babbitt, battery plates, solder, pewter, and type metal. Antimony used in the rubber, glass, enamel, paint, and ceramic industries is not recoverable.[10]

IMPORTS AND EXPORTS

The accompanying statistics are compiled from the records of the Bureau of Foreign and Domestic Commerce, United States Department of Commerce. The imports are reported as (1) imports for consumption, including merchandise entered for immediate consumption or withdrawn from bonded warehouse for consumption, and (2) total or general imports. Only general imports are listed by countries of origin.

Antimony imported for consumption in the United States, 1919–1923

Year	Antimony ore [a]			Liquated antimony sulphide [b]		Metallic antimony [c]		Antimony oxides and other compounds [d]	
	Short tons	Antimony content		Short tons	Value	Short tons	Value	Short tons	Value
		Short tons	Value						
1919	993	409	$54,477	278	$19,202	7,159	$1,021,587	126	$9,501
1920	1,709	682	70,285	1,375	123,902	9,817	1,216,376	298	25,260
1921	213	98	11,682	353	17,577	10,130	784,146	154	15,558
1922				689	40,108	9,344	659,242	379	65,538
1923	(e)	1,047	44,721	835	64,493	6,763	641,804	2,277	288,206

[a] Classified in tariff classification as "Antimony ore and stibnite containing antimony."
[b] Classified in tariff classification as "Antimony matte, containing not more than 10 per cent of lead"; also as "needle or liquated antimony."
[c] Classified in tariff classification as "Antimony regulus or metal."
[d] Classified in tariff classification as "Antimony, oxide, salts, and compounds of."
[e] Not available.

Antimony imported into the United States in 1919–1923 [a]

[General imports]

Country	Antimony ore			Antimony metal [b]	
	Short tons	Antimony content		Pounds	Value
		Pounds	Value		
1919					
Canada		28	$10	2,308,880	$167,764
Chile [c]	47	49,624	6,312		
China [d]	455	362,326	23,936	7,847,840	459,613
England				90,048	8,803
Hongkong [d]	4	4,510	493	68,320	3,949
India (British)				224,000	10,976
Japan [d]				2,953,994	159,091
Mexico	297	219,048	11,332	757,076	60,571
Panama	2	1,200	99		
Peru	74	90,726	7,345		
	879	727,462	49,527	14,250,158	870,767

[a] Includes large quantities of antimony metal that went into bonded warehouse and that are not included in the table of imports for consumption.
[b] Includes small quantities of liquated antimony sulphide, known in the trade as "crude antimony," "antimony matte," or "needle antimony."
[c] Imports credited to Chile originated mainly in Bolivia.
[d] Nearly all the imports of antimony ore and metal from Hongkong and Japan are of Chinese origin. Some of the material credited to other countries is possibly also of Chinese origin, having been transshipped in a foreign port.

[10] Dunlop, J. P., U. S. Geol. Survey Mineral Resources, 1923, pt. 1, p. 271, 1924.

Antimony imported into the United States in 1919–1923—Continued

Country	Antimony ore			Antimony metal	
	Short tons	Antimony content		Pounds	Value
		Pounds	Value		
1920					
Bolivia [c]	388	335,061	$22,941		
Canada	132	19,457	2,179	225,272	$19,111
Chile [c]	162	152,276	11,963		
China [d]	420	450,293	14,185	21,564,851	1,218,802
England				125,539	14,638
France	467	315,861	10,605		
Hongkong [d]	75	10,200	4,556	706,156	44,909
Japan [d]				2,325,303	177,816
Panama	65	80,293	3,856		
	1,709	1,363,441	70,285	24,947,121	1,475,276
1921					
Bolivia [c]	45	46,600	2,450		
Chile [c]	49	54,401	3,334		
China [d]				20,530,079	672,501
England				302,457	14,586
Germany				45	7
Hongkong [d]	119	95,106	5,898		
Japan [d]				320,750	10,027
	213	196,107	11,682	21,153,331	697,121
1922 [e]					
Canada				8,960	364
China [d]				16,976,726	562,181
England				45,474	3,335
France				22	4
Germany				515	65
Hongkong [d]				627,424	30,531
Netherlands				84,744	3,813
				17,743,865	600,293
1923					
Australia	(f)	113,864	4,901		
Belgium				38,715	2,420
Bolivia [c]	(f)	176,368	3,937		
Canada				55,740	3,848
Chile [c]	(f)	1,169,784	25,644		
China [d]				13,185,898	558,771
England [g]	(f)	1,340	102	1,410,198	99,927
France	(f)	111,026	1,020		
Germany [g]	(f)	1,800	906	750,555	44,953
Hongkong [d]				73,762	3,385
Italy				60	9
Japan [d]				56,000	2,074
Mexico	(f)	519,913	8,211		
Straits Settlements				56,000	2,682
	(f)	2,094,095	44,721	15,626,928	718,069

[c] Imports credited to Chile originated mainly in Bolivia.

[d] Nearly all the imports of antimony ore and metal from Hongkong and Japan are of Chinese origin. Some of the material credited to other countries is possibly also of Chinese origin, having been transshipped in a foreign port.

[e] No ore was imported in 1922.

[f] The Department of Commerce does not give the figures for imports of antimony ore in 1923.

[g] England and Germany are the only countries from which imports of both ore and metal were received. The total imports from England were 1,411,538 pounds of antimony metal, valued at $100,029; and those from Germany were 752,355 pounds, valued at $45,859.

The total general imports of 17,721,023 pounds in 1923 show a decrease of about 0.13 per cent in quantity and an increase of 27 per cent in value as compared with 1922. They were derived from 14 different countries as compared with 7 countries in 1922. The

additional countries contributing were Australia, Belgium, Bolivia, Chile, Italy, Japan, Mexico, and Straits Settlements; the Netherlands dropped out. Italy and the Straits Settlements are new contributors, this being the first time that imports have been received from them.

Nearly 75 per cent of the imports in 1923 came from China, 8 per cent from England, and 7 per cent from Chile. These countries were followed by Germany, with 4 per cent, and Mexico, with 3 per cent. Mexico was an important contributor during the war but until 1923 had not shipped antimony to the United States since 1919.

Of the total imports 12 per cent came as ore, more than half of it from Chile, whose shipments were all ore. With the rapid development of the antimony smelting and refining industry in China occasioned by the World War, only small if any imports of ore and but few of crude antimony can be expected from that country.

The imports amounted to 714,943 pounds in January and 1,926,848 pounds in December. They were heaviest during the middle part of the year and were at a maximum of 2,839,626 pounds in May and a minimum of 169,885 pounds in February.

For many years large quantities of antimonial lead have been imported into the United States as type metal, for which it is largely used, but from 1912 to 1918 these imports declined. In 1919, however, after the World War had ended, they increased to 6,697 tons, and they continued to increase each succeeding year until in 1922 they amounted to 21,683 tons. They came mostly from Canada and consisted largely of shrapnel lead, which contains about the same per cent of antimony as type metal.

Type metal imported for consumption in the United States, 1919–1923

Year	Type metal		Assumed antimony content	
	Short tons	Value	Short tons	Percentage
1919	6,697	$816,642	1,197	17.9
1920	14,944	1,349,495	2,063	13.8
1921	19,485	1,191,553	4,132	21.2
1922	21,683	1,082,832	5,290	24.4
1923	[a] 3,677	[a] 431,610	(b)	(b)

[a] Lead content only. Figures for gross weight not available.
[b] Data not available.

The customs returns give only the lead content of imported type metal, and the figures given above are based on the assumption that the remainder is practically all antimony, but this assumption is arbitrary, for imported type metal contains as much as 2 per cent of impurities, such as iron, arsenic, and copper. The antimony content is therefore probably too large by some quantity less than or approximately equal to 2 per cent of the total quantity of type metal, and the correct percentage is correspondingly lower.

Foreign antimony exported from the United States, 1919–1923 [a]

Year	Ore			Matte, regulus, or metal	
	Short tons	Antimony content		Pounds	Value
		Pounds	Value		
1919	3	5,380	$1,665	429,059	$33,913
1920				896,034	51,607
1921				299,776	15,741
1922				37,218	1,548
1923				15,958	1,047

[a] During 1922 there was also exported, mainly to Canada, 224,610 pounds of regulus or metal of domestic manufacture, valued at $13,961. This is the first export of domestic antimony of which there is any record. However, antimony manufactured in the United States from foreign ores and exported would also be classed as domestic exports. Similar exports for 1923 are not shown.

STOCKS

Stocks of antimony in 1923 were not large. The monthly average stocks of regulus and matte remaining in bonded warehouses during 1923, according to the Bureau of Foreign and Domestic Commerce, amounted to 1,216,460 pounds, as compared with 1,861,831 pounds in 1922. From 1,013,008 pounds at the beginning of the year the stocks decreased to 923,856 pounds by the end of January; thence they continued to decrease almost steadily until they reached their minimum of 436,465 pounds by the end of April. They increased to 787,931 pounds by the end of May, to 982,811 pounds by the end of June, to 1,338,971 pounds by the end of July, and to 2,294,831 pounds, the highest monthly figure for the year, by the end of August. They then decreased to 2,201,734 pounds by the end of September, to 1,640,630 pounds by the end of October, to 1,353,189 pounds by the end of November, and to 1,375,589 pounds by the end of the year, as compared with 1,013,008 pounds at the end of 1922. They were heaviest in the third quarter of the year, during which their monthly average was nearly 2,000,000 pounds, and the average for the two months August and September was nearly 1,250,000 pounds. A general comparison for the last four years is graphically shown in Figure 12 (p. 279).

There also remained in the warehouses at the end of the year 5,360 pounds of type metal.

PRICES

The average yearly New York quotations for the ordinary grades of metallic antimony for the last 29 years, according to the American Metal Market, are as follows:

Average New York quotations for metallic antimony, 1895–1923, in cents per pound

1895–1904	7.53	1915	29.52
1905–1907	13.72	1916	25.33
1908	7.80	1917	20.73
1909	7.35	1918	12.55
1910	7.27	1919	8.16
1911	7.48	1920	8.38
1912	7.63	1921	4.92
1913	7.43	1922	5.42
1914	8.53	1923	7.81

WORLD'S PRODUCTION

Because of the various and not strictly comparable terms in which production is reported in most foreign countries it is impossible to give more than a rough comparison between the principal important producers. As nearly as can be estimated the yearly production of antimony ore, for which even approximately complete statistics are not available, amounts to about 25,000 metric tons of recoverable antimony, exclusive of the antimony content of antimonial lead ores. The relative importance of the principal producing countries in terms of percentages of the world's normal output for 1913 is about as follows:

Percentages of the world's production of antimony in 1913, by countries

Algeria	1	France	21
Asia Minor	1	Italy	1
Australia (Victoria)	4	Mexico	10
Austria-Hungary	8	Serbia	1
China	53		

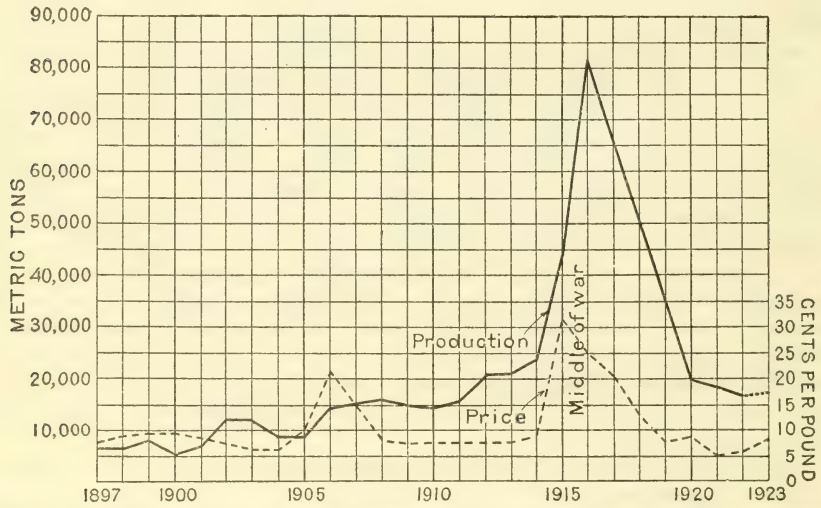

FIGURE 13.—World's production of antimony, 1897–1923, based on estimated recoverable content of antimony ore, and average price per pound in New York

From 1908 to the outbreak of the World War in 1914 more than 50 per cent and since 1914 more than 60 per cent of the world's production of antimony has come from China. At the time China's maximum production was reached (42,800 tons, in 1916) the production of all other countries combined was nearly as much, but during 1922 the greatly reduced output of China, due to the very low prices, represented at least 90 per cent of all ore mined in the world, and in 1923 China's output, so far as preliminary data indicate, was about 85 per cent of the world's production.

The following table shows the world's production for the years 1917–1923 so far as reasonably approximate data are available. An attempt has been made to reduce all statistics of production to a common basis—that of the recoverable metal content of the ore produced. The figures do not imply that this quantity of metallic anti-

mony was actually produced. A part of the ore goes directly into the manufacture of oxides and other salts, and in recent years lead smelters have purchased antimony ore which is smelted with lead ore for the direct production of antimonial lead. On the other hand, a small quantity of antimony is produced by lead refineries, and the antimony content of antimonial lead ores is not included in the table because sufficient data are not available.

It is evident that the world's present capacity to produce antimony far exceeds the normal demand. New deposits of antimony ore are being found from time to time. One was recently discovered at Gresford, near Paterson, New South Wales,[11] one in Camas County, Idaho, and one in Tulare County, Calif.

The following table was prepared by Miss L. M. Jones, of the United States Geological Survey:

World's production of antimony, 1917–1923, in metric tons

[Approximate recoverable metal content of ore produced, exclusive of antimonial lead ores]

Country	1917	1918	1919	1920	1921	1922	1923
North America:							
Canada	87	[a] 7	[a] 14				
Mexico	2,647	3,279	471	623	45	464	490
United States	310	45				4	8
South America:							
Argentina [b]	650	360	27	50	(c)	(c)	(c)
Bolivia [a]	10,288	3,010	105	484	282	185	312
Peru [a]	433	155	30	7	7		
Europe:							
Austria	38		1			139	62
Czechoslovakia	(d)	(c)	153	330	384	100	(c)
France	2,354	1,329	998	1,130	1,276	656	437
Greece			55	46			
Hungary	406	(c)	66	93			(c)
Italy	689	404	10	187	76	146	271
Spain	148	22					25
Yugoslavia	725	(c)	(c)	(c)	(c)	(c)	131
Asia:							
China [a]	28,450	15,597	7,721	13,001	14,658	13,858	[e] 14,500
India, British	61		2		1		
Indo-China	[a] 800	(c)	(c)	(c)	(c)	(c)	(c)
Japan	1,606	95	1				
Turkey (Asia Minor)	[f] 400	[f] 400	[f] 400	[f] 400	[f] 400	[f] 400	[f] 400
Africa:							
Algeria [a]	4,550	2,218	723	1,000	103	579	500
Nigeria [a]			(g)	(g)	(g)	(g)	(c)
Rhodesia, Southern	3	3		2			
Union of South Africa	232	38	10				
Oceania:							
Australia—							
New South Wales	150	143	70	81	50		
Victoria	1,045	509	491	406	141	605	421

[a] Exports.
[b] Railway shipments. A large part of the shipments reported are probably of Bolivian origin and therefore may duplicate in part the quantities shown for Bolivia.
[c] Data not available.
[d] Included under Austria and Hungary.
[e] Calculated from estimates in Mining Industry, vol. 32, p. 46, 1923.
[f] Estimated.
[g] Less than 1 ton. The estimated recoverable metal content of ores exported was as follows: 1919, 169 kilograms; 1920, 178 kilograms; 1921, 74 kilograms; 1922, 190 kilograms.

[11] Chem. Eng. and Min. Review, Jan. 25, 1924, p. 127.

IRON ORE, PIG IRON, AND STEEL

By Ernest F. Burchard and Hubert W. Davis [1]

GENERAL REVIEW

The production and shipments of iron ore increased 47 per cent and 38 per cent respectively in 1923 as compared with 1922. The production was the fourth largest on record, ranking about with that of 1918, and was 126 per cent of the average for the preceding 5 years and 119 per cent of the average for the preceding 10 years. The output of pig iron increased 48 per cent as compared with 1922 and was about 129 per cent of the average for the preceding 10 years and about 134 per cent of the average for the preceding 5 years. This output was the largest ever produced and was about 1,000,000 tons more than that of 1916, the largest previously recorded.

The average price per ton for iron ore at the mines increased about 11 per cent and that of pig iron at the blast furnaces about 12 per cent. The quoted prices of ferromanganese, spiegeleisen, and steel showed considerable increases. In point of operations, production, and earnings 1923 was the most remarkable peace-time year in the history of the steel industry.

The labor situation was fairly satisfactory in the Lake Superior iron-mining districts during the year, although early in the season mine labor was scarce and some of the mines went on a single shift, but this situation was relieved during the summer. A general wage advance of 10 per cent was made early in the spring. The movement toward the abolition of the 12-hour day in the steel industry made by the President of the United States at a conference with representative manufacturers in May, 1922, was followed by a serious effort on the part of the manufacturers to find ways and means to accomplish this end. A step in this direction was made on August 16, 1923, when the Carnegie Steel Co. changed to the 8-hour day, and subsequently other producers took steps to abolish the long day.

The railroads were the leading buyers of steel in 1923, followed by the building and general construction industry, and there was also a good demand for steel by the oil and gas industries and for agricultural uses.

The total domestic output of pig iron probably required about 77 per cent of the apparent maximum capacity of the country, according to figures of the American Iron and Steel Institute, but this capacity was not utilized steadily, for at the beginning of 1923 there were only

[1] Figures of imports and exports compiled by J. A. Dorsey, of the U. S. Geological Survey, from records of the Bureau of Foreign and Domestic Commerce.

263 furnaces in blast; on June 30 there were 335, and at the end of the year 239. The production of steel ingots is also considered to have utilized about 77 per cent of the manufacturing capacity, the output having ranged from about 60 per cent of the capacity in December to 89 per cent in May. The output of pig iron in the United States represented about 60 per cent of the world's production and nearly twice that of all the producing countries of Europe combined. The production of these European countries decreased about 3 per cent, compared with an increase of 48 per cent in the United States. Decreases in exports indicate that the United States is not contributing large quantities of iron and steel toward the rehabilitation of Europe, and increases in imports from war-stricken European countries indicate that their products are continuing to invade American markets.

A concise summary of the important features of the year, chiefly relating to the Lake Superior district, is given by Woodbridge,[2] as follows:

> The year in iron ore has been characterized by intensive production; remarkable coordination in transportation all the way from mines to furnaces, also cooperation between mines and railroads; an extension of projects for beneficiation of lean ores; almost a total lack of exploration for ore bodies in Minnesota and renewed activity elsewhere; an emphasis in the trend toward closer grading on manganese content, which had been more or less marked for some time; severe competition of imported ores along the Atlantic coast, which is usually served to some extent from Lake Superior; important all-rail shipments to furnaces in the Central West and South; freedom from labor troubles, and a good supply of men in all branches of the ore and transportation industry; a closer control of ores by larger organizations; the grinding out in Minnesota of smaller and independent holders of ore by the inexorable pressure of applied socialism; and the definite declaration of a policy for the bonusing of beneficiated ores produced in the Province of Ontario.

IRON ORE

QUANTITIES MINED AND SHIPPED IN 1923

The quantities of iron ore shown in the accompanying table include beneficiated ore instead of crude ore mined if the ore is treated in any way. The quantities of ore, both mined and shipped, stated in the tables include the iron ore used for fluxing other metallic ores at smelters in the Western States, but the shipments do not include the iron ore sold for the manufacture of paint, which amounted in 1923 to 24,842 gross tons, valued at $140,306, or $5.65 a ton, compared with 27,382 tons, valued at $166,682, or $6.09 a ton, in 1922. The manganiferous iron ore (including ore used for flux), which contained 5 per cent or more of manganese, amounted to 1,433,897 gross tons, valued at $4,888,393. In Arkansas one producer shipped a small quantity of loadstone. This shipment, together with 8,209 gross tons of arsenical iron ore shipped in 1923, is not included in the tabulated statistics of iron ore.

Iron ore was mined in 20 States in both 1922 and 1923. All the iron ore produced in Idaho, Montana, and Nevada and the greater part of that produced in California and Utah was used for flux; a small quantity of ore from New Jersey and Pennsylvania was used for purifying gas; the remaining States produced iron ore mainly for

[2] Woodbridge, D. E., Intensive production of Lake Superior ores: Iron Age, Jan. 3, 1924, p. 74.

use in blast furnaces, except small quantities from California, Michigan, New York, Pennsylvania, Tennessee, and Wisconsin that were used for paint. The rank of the three States producing the largest quantity of iron ore—Minnesota, Michigan, and Alabama—remained practically unchanged. The Minnesota iron ranges are producing more iron ore than all the rest of the States together, having furnished nearly 61 per cent of the total for the United States in the last five years.

The ores of iron are classed under the four heads hematite, brown ore, magnetite, and carbonate.[3]

Iron ore mined in the United States in 1922 and 1923, by States and varieties, in gross tons, with percentage of increase or decrease in 1923

[Exclusive of ore containing 5 per cent or more of manganese]

State	Hematite	Brown ore	Magnetite	Carbonate	Total	Percentage of increase or decrease in 1923
1922						
Alabama	4,619,395	615,173			5,234,568	
California			3,204		3,204	
Colorado		513			513	
Georgia	120	24,029			24,149	
Idaho		200			200	
Michigan	10,453,578				10,453,578	
Minnesota	28,748,106		20,854		28,768,960	
Missouri	57,038	1,370			58,408	
Montana	(a)	[a] 21,726			21,726	
Nevada		51			51	
New Jersey			90,359		90,359	
New Mexico			118,038		118,038	
New York	14,769		429,612		444,381	
North Carolina		12,958	4,321		17,279	
Pennsylvania		861	776,719	3,256	780,836	
Tennessee	74,928	81,536			156,464	
Utah	(a)	[a] 6,355	8,663		15,018	
Virginia	12,161	18,810			30,971	
Wisconsin	575,828		1,196		577,024	
Wyoming	332,800				332,800	
	[a] 44,888,723	[a] 783,582	1,452,966	3,256	47,128,527	
1923						
Alabama	5,983,568	799,578			6,783,146	+30
California			2,779		2,779	−13
Colorado		4,102			4,102	+700
Georgia	21,193	96,128			117,321	+386
Idaho	1,290				1,290	+545
Michigan	14,174,468				14,174,468	+36
Minnesota	44,262,908		85,388		44,348,296	+54
Missouri	40,630	12,916			53,546	−8
Montana	(a)	[a] 17,751			17,751	−18
Nevada		9,578			9,578	+18,680
New Jersey			307,733		307,733	+241
New Mexico			205,218		205,218	+74
New York	12,849		529,073		541,922	+22
North Carolina		13,899	45,785		59,684	+245
Pennsylvania		1,284	988,641	3,516	993,441	+27
Tennessee	165,630	101,645			267,275	+71
Utah	[a] 2,700	[a] 32,331	22,721		57,752	+285
Virginia	12,341	143,636			155,977	+404
Wisconsin	868,130		3,286		871,416	+51
Wyoming	378,747				378,747	+14
	[a] 65,924,454	[a] 1,232,848	2,190,624	3,516	69,351,442	+47

[a] Some hematite included with brown ore.

The ore reported as sold for fluxing other than in the manufacture of pig iron amounted to 86,869 gross tons, valued at $300,318, as compared with 40,155 tons, valued at $143,100, in 1922. The ore reported

[3] Notes concerning the composition of these ores are given in U. S. Geol. Survey Mineral Resources, 1916, pt. 1, pp. 537–541, 1918.

as sold for purifying gas amounted to 1,241 gross tons, valued at $11,285. The domestic iron ore sold for the manufacture of pig iron amounted to 69,723,362 gross tons, valued at $240,427,318, compared with 50,571,595 tons, valued at $157,657,188, in 1922.

A comparison of the annual production of iron ore and its derived metals, pig iron and steel, since 1870 is afforded by the curves shown in Figure 14. The figures for the three products are not strictly com-

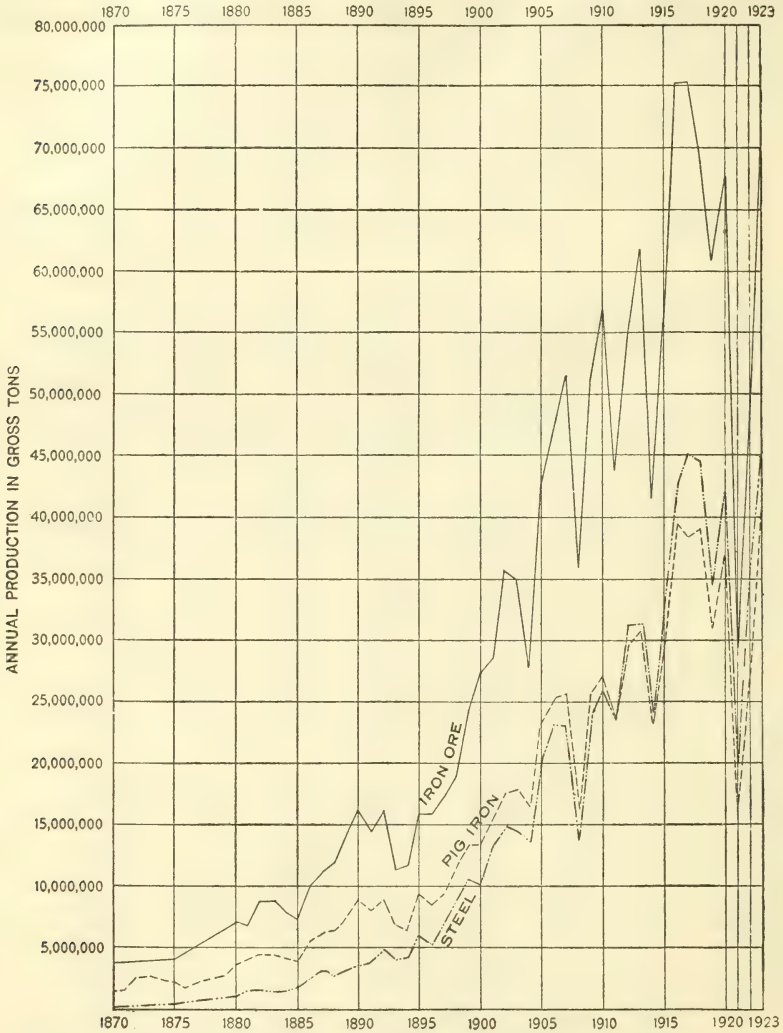

FIGURE 14.—Annual production of iron ore, pig iron, and steel in the United States, 1870–1923

parable, however, because considerable foreign iron ore and also some cinder, scale, and scrap enter into the production of domestic pig iron, and considerable scrap iron and steel, as well as cinder and scale, enter into the production of new steel.

In response to inquiries as to the quantities of iron ore used for paint and flux the shipments by States have been subdivided into the several uses reported as shown in the next table.

Iron ore shipped from mines in the United States in 1923, by States and uses, in gross tons

[Exclusive of ore containing 5 per cent or more of manganese]

State	Pig iron	Flux	Paint	Other	Total
Alabama	6, 922, 663				6, 922, 663
California		2, 769	10		2, 779
Colorado	4, 102				4, 102
Georgia	117, 286				117, 286
Idaho		1, 290			1, 290
Michigan	14, 065, 561		4, 377		14, 069, 938
Minnesota	44, 556, 053				44, 556, 053
Missouri	54, 348				54, 348
Montana		17, 751			17, 751
Nevada		9, 578			9, 578
New Jersey	349, 148			287	349, 435
New Mexico	205, 218				205, 218
New York	722, 096		12, 849		734, 945
North Carolina	59, 684				59, 684
Pennsylvania	987. 632		3, 516	954	992, 102
Tennessee	266, 175		1, 100		267, 275
Utah	2, 271	55, 481			57, 752
Virginia	200, 966				200, 966
Wisconsin	831, 412		2, 990		834, 402
Wyoming	378, 747				378, 747
	69, 723, 362	86, 869	24, 842	1, 241	69, 836, 314

Iron ore shipped from mines in the United States, 1922 and 1923, by States

[Exclusive of ore containing 5 per cent or more of manganese and of ore sold for paint]

State	1922		1923		Percentage of increase or decrease	
	Gross tons	Value	Gross tons	Value	Quantity	Value
Alabama	5, 294, 520	$8, 791, 069	6, 922, 663	$15, 540, 198	+31	+77
California	3, 204	18, 868	2, 769	18, 665	−14	−1
Colorado	513	[a]	4, 102	[a]	+700	
Georgia	28, 566	77, 636	117, 286	300, 712	+311	+287
Idaho	25	[a]	1, 290	[a]	+5, 060	
Massachusetts	4, 368	[a]			−100	−100
Michigan	12, 457, 856	43, 449, 513	14, 065, 561	54, 110, 070	+13	+25
Minnesota	30, 209, 372	98, 903, 398	44, 556, 053	158, 402, 788	+47	+60
Missouri	58, 320	244, 928	54, 348	247, 975	−7	+1
Montana	21, 726	59, 566	17, 751	51, 039	−18	−14
Nevada	25	[a]	9, 578	[a]	+38, 212	
New Jersey	90, 374	400, 356	349, 435	1, 403, 723	+287	+251
New Mexico	118, 038	[a]	205, 218	[a]	+74	
New York	191, 195	1, 049, 050	722, 096	3, 242, 229	+278	+209
North Carolina	19, 279	49, 415	59, 684	161, 603	+210	+227
Pennsylvania	782, 916	1, 022, 756	988, 586	2, 264, 485	+26	+121
Tennessee	159, 473	418, 578	266, 175	677, 753	+67	+62
Utah	15, 018	63, 806	57, 752	205, 936	+285	+223
Virginia	30, 359	120, 685	200, 966	664, 240	+562	+450
Wisconsin	794, 673	2, 455, 660	831, 412	2, 421, 194	+5	−1
Wyoming	332, 800	[a]	378, 747	[a]	+14	
Undistributed		[b] 684, 002		[b] 1, 026, 311		
	50, 612, 620	157, 809, 286	69, 811, 472	240, 738, 921	+38	+53

[a] Included under "Undistributed."
[b] This figure includes value for States entered as "(a)" above.

The Lake Superior district, comprising Minnesota, Michigan, and northern Wisconsin, mined about 85 per cent of the total ore in 1923, and the Birmingham district, in Alabama, mined a little less than 9 per cent of the total.

Iron ore mined in the United States, by mining districts and varieties, in 1922 and 1923, in gross tons

[Exclusive of ore containing 5 per cent or more of manganese]

District	Hematite	Brown ore	Magnetite	Carbonate	Total	Percentage of increase in 1923
1922						
Lake Superior [a]	39,693,966		22,050		39,716,016	
Birmingham	4,429,170	282,230			4,711,400	
Chattanooga	250,083	122,121			372,204	
Adirondack			406,342		406,342	
Northern New Jersey and southeastern New York			113,629		113,629	
Other districts	[b] 515,504	[b] 379,231	910,945	3,256	1,808,936	
	[b] 44,888,723	[b] 783,582	1,452,966	3,256	47,128,527	
1923						
Lake Superior [a]	59,196,734		88,674		59,285,408	49
Birmingham	5,740,233	306,675			6,046,908	28
Chattanooga	404,948	229,102			634,050	70
Adirondack			460,311		460,311	13
Northern New Jersey and southeastern New York			376,495		376,495	231
Other districts	[b] 582,539	[b] 697,071	1,265,144	3,516	2,548,270	41
	[b] 65,924,454	[b] 1,232,848	2,190,624	3,516	69,351,442	47

[a] Includes only those mines in Wisconsin which are in the true Lake Superior district.
[b] Some hematite included with brown ore.

The following table shows the production of iron ore in the United States so far as it has been recorded or estimated. The figures for the years prior to 1860 are not strictly accurate, having been calculated from the pig iron produced, which included imported ore as well as domestic ore. Details for the years 1880 to 1916 will be found in Mineral Resources for 1916.

Iron ore mined in the United States, 1810–1923, in gross tons

[Exclusive after 1905 of ore containing 5 per cent or more of manganese]

Year	Hematite	Brown ore	Magnetite	Carbonate	Total
1810–1869					49,656,000
1870[a]–1880					51,690,889
1881–1890					103,854,386
1891–1900	136,961,046	22,845,764	14,634,364	1,065,137	175,506,311
1901–1910	364,179,432	[b] 28,287,994	[b] 20,664,453	262,366	413,394,245
1911–1915	239,419,251	8,355,102	10,156,539	42,495	257,973,387
1916	70,728,024	1,904,484	2,533,364	1,800	75,167,672
1917	70,743,513	1,992,332	2,553,006		75,288,851
1918	65,894,709	1,613,844	2,149,725		69,658,278
1919	[c] 57,719,582	1,127,397	[c] 2,118,439		60,965,418
1920	[c d] 63,883,523	[d] 1,325,661	[c] 2,391,541	3,740	67,604,465
1921	[c d] 28,337,249	[d] 370,154	[c] 780,866	2,709	29,490,978
1922	[d] 44,888,723	[d] 783,582	1,452,966	3,256	47,128,527
1923	[d] 65,924,454	[d] 1,232,848	2,190,624	3,516	69,351,442
					1,546,730,849

[a] Includes ore produced by owners of blast furnaces, estimated by census at 800,000 tons.
[b] Some brown ore included with magnetite.
[c] Some magnetite included with hematite.
[d] Some hematite included with brown ore.

PRINCIPAL IRON-ORE MINES

In 1923 there were 309 iron-ore mines active, compared with 293 in 1922 and 256 in 1921; 139 mines produced more than 100,000 gross tons of iron ore each, compared with 109 in 1922 and 65 in 1921. Of these 139 mines 9 (7 in Minnesota, 1 in Alabama, and 1 in Michigan) produced more than 1,000,000 tons each, as against 7 (5 in Minnesota,

1 in Alabama, and 1 in Michigan) in 1922 and 5 (3 in Minnesota, 1 in Alabama, and 1 in Michigan) in 1921. Permission has been granted to the Geological Survey by the operators of all except two of these large mines to publish their production, and these statistics are given in the following table. The trend toward large mining units is shown in the production of 93 per cent of the output of the country by the 139 mines that yielded more than 100,000 tons each.

Iron-ore mines of the United States that produced more than 100,000 gross tons each in 1923

Rank	Name of mine	State	Nearest town	Variety of ore	Gross tons
1	Hull-Rust	Minnesota	Hibbing	Hematite	8,823,879
2	Missabe Mountain	do	Virginia	do	3,933,116
3	Red Mountain group	Alabama	Bessemer	do	3,174,215
4	Mahoning	Minnesota	Hibbing	do	3,029,865
5	Spruce	do	Eveleth	do	1,708,277
6	Norrie group	Michigan	Ironwood	do	1,449,153
7	Canisteo	Minnesota	Coleraine	do	1,350,604
8	Little and Prindle	do	Keewatin	do	1,154,702
9	Hill Annex	do	Calumet	do	1,098,692
10	Cornwall	Pennsylvania.	Miners Village	Magnetite	924,186
11	Morris	Minnesota	Hibbing	Hematite	906,496
12	Woodward Nos. 1, 2, and 3	Alabama	Bessemer	do	884,694
13	Leonidas	Minnesota	Eveleth	do	881,053
14	Plymouth	Michigan	Verona	do	827,410
15	Holman	Minnesota	Taconite	do	793,321
16	Bennett	do	Keewatin	do	768,746
17	Hawkins	do	Nashwauk	do	759,273
18	Dunwoody	do	Chisholm	do	752,001
19	Newport (including Bonnie)	Michigan	Ironwood	do	728,603
20	Arcturus	Minnesota	Marble	do	718,081
21	Kerr	do	Hibbing	do	685,618
22	Susquehanna	do	do	do	617,615
23	St. James	do	Aurora	do	602,963
24	Patrick	do	Pengilly	do	588,510
25	North Harrison	do	do	do	550,815
26	Pioneer	do	Ely	do	505,304
27	Boeing	do	Hibbing	do	503,888
28	Glen	do	Chisholm	do	494,012
29	Adams	do	Eveleth	do	487,307
30	Montreal	Wisconsin	Hamilton	do	483,024
31	Sloss Nos. 1 and 2	Alabama	Bessemer	do	459,914
32	Chapin (including Millie)	Michigan	Iron Mountain	do	457,275
33	Dean	Minnesota	Buhl	do	446,696
34	Raimund Nos. 1 and 2	Alabama	Bessemer	do	431,865
35	Bristol	Michigan	Crystal Falls	do	429,836
36	Webb	Minnesota	Hibbing	do	408,295
37	Odgers	Michigan	Crystal Falls	do	407,809
38	Scranton	Minnesota	Hibbing	do	402,716
39	Wakefield	Michigan	Wakefield	do	392,144
40	Negaunee	do	Negaunee	do	381,915
41	Shenango	Minnesota	Chisholm	do	381,082
42	Palms	Michigan	Bessemer	do	378,953
43	Sunrise	Wyoming	Sunrise	do	378,747
44	St. Paul	Minnesota	Keewatin	do	371,935
45	Leonard	do	Chisholm	do	368,219
46	Armour No. 2 (including Cuyuna-Duluth).	do	Crosby	do	356,119
47	Ironton	Michigan	Bessemer	do	348,073
48	Danube	Minnesota	Bovey	do	338,206
49	Songo	Alabama	Bessemer	do	320,033
50	Lake Superior	Michigan	Ishpeming	do	315,351
51	Chisholm	Minnesota	Chisholm	do	312,134
52	Biwabik (including Cincinnati)	do	Biwabik	do	303,727
53	Fayal	do	Eveleth	do	301,822
54	Utica	do	Hibbing	do	301,730
55	Hill-Trumbull	do	Marble	do	300,359
56	Zenith	do	Ely	do	297,702
57	Cliffs Shaft	Michigan	Ishpeming	do	290,615
58	Russellville	Alabama	Russellville	Brown ore	285,773
59	South Judd	Minnesota	Taconite	Hematite	285,392
60	Albany	do	Hibbing	do	281,129
61	Eureka	Michigan	Ramsay	do	277,799
62	Holmes	do	Ishpeming	do	276,672
63	Richmond	do	Palmer	do	271,492
64	Aragon	do	Norway	do	269,168
65	Burt	Minnesota	Hibbing	do	266,760
66	Morris-Lloyd	Michigan	Ishpeming	do	260,335
67	Caspian	do	Caspian	do	256,760

Iron-ore mines of the United States that produced more than 100,000 gross tons each in 1923—Continued

Rank	Name of mine	State	Nearest town	Variety of ore	Gross tons
68	Warren	Minnesota	Carson Lake	Hematite	252,759
69	Bengal	Michigan	Stambaugh	do	248,419
70	Stephenson	do	Gwinn	do	247,212
71	Athens	do	Negaunee	do	245,545
72	Laura	Minnesota	Hibbing	do	243,727
73	Corsica	do	McKinley	do	240,892
74	Rogers	Michigan	Iron River	do	237,324
75	Maas	do	Negaunee	do	227,792
76	Sunday Lake	do	Wakefield	do	226,652
77	Alexandria	Minnesota	Chisholm	do	226,649
78	Kennedy	do	Cuyuna	do	225,148
79	Lincoln	do	Virginia	do	223,515
80	Maroco	do	Ironton	do	222,629
81	Homer	Michigan	Iron River	do	217,224
82	Cary	Wisconsin	Hurley	do	214,070
83	Billings	Minnesota	Chisholm	do	209,835
84	North Anvil	Michigan	Bessemer	do	208,899
85	Harold	Minnesota	Stuntz	do	206,959
86	Wellington	do	Chisholm	do	205,368
87	Leetonia	do	Carson Lake	do	204,737
88	Kinney	do	Kinney	do	202,294
89	Rolling Mill	Michigan	Negaunee	do	199,677
90	Hobart	Minnesota	Gilbert	do	193,927
91	Balkan (including Judson)	Michigan	Alpha	do	190,040
92	Berkshire	do	Stambaugh	do	189,790
93	La Rue	Minnesota	Nashwauk	do	183,307
94	Imperial	Michigan	Michigamme	do	178,730
95	Monongahela	do	Crystal Falls	do	178,133
96	Riverton group	do	Iron River	do	172,608
97	Harmony	New York	Mineville	Magnetite	172,127
98	Union Hill (including Republic)	New Mexico	Fierro	do	170,042
99	Penn group	Michigan	Norway and Vulcan	Hematite	168,234
100	Isabella	do	Palmer	do	166,022
101	Mary Charlotte	do	Negaunee	do	164,907
102	Sellers	Minnesota	Hibbing	do	162,488
103	Shannon	Alabama	Birmingham	do	159,591
104	Hiawatha	Michigan	Iron River	do	159,291
105	Pennington	Minnesota	Ironton	do	155,748
106	South Agnew	do	Buhl	do	153,887
107	Majorca	do	Gilbert	do	151,743
108	Fay	do	Virginia	do	149,289
109	Carpenter	Michigan	Crystal Falls	do	149,075
110	Sargent	Minnesota	Keewatin	do	146,561
111	Cambria (including Lillie)	Michigan	Negaunee	do	143,934
112	Yale	do	Bessemer	do	140,822
113	Attalla No. 1	Alabama	Attalla	do	139,110
114	Irondale Nos. 2 and 3	do	Irondale	do	138,583
115	State Lease 40	Minnesota	Crosby	do	138,505
116	Minnewas	do	Virginia	do	134,747
117	Croft	do	Crosby	do	133,520
118	Sweeney	do	Hibbing	do	132,476
119	Soudan	do	Soudan	do	130,915
120	Smith	do	Hibbing	do	129,584
121	Baltic (including Fogarty and Buck).	Michigan	Palatka	do	129,415
122	Brunt	Minnesota	Mountain Iron	do	126,192
123	Mount Hope	New Jersey	Mount Hope	Magnetite	125,825
124	Asteroid	Michigan	Ramsay	Hematite	122,497
125	Lamberton	Minnesota	Hibbing	do	122,070
126	Davidson No. 1	Michigan	Iron River	do	117,011
127	York	Minnesota	Nashwauk	do	116,742
128	Townsite	Michigan	Ironwood	do	114,667
129	Wanless	Minnesota	Buhl	do	113,069
130	[a]	[a]	[a]	[a]	111,040
131	Francis	Michigan	Gwinn	Hematite	110,550
132	Miller	Minnesota	Aurora	do	109,870
133	Baker	Tennessee	Rockwood	do	109,766
134	Mariska	Minnesota	Gilbert	do	109,360
135	Mayville	Wisconsin	Mayville	do	107,613
136	Republic (including West Republic).	Michigan	Republic	do	105,863
137	Belgrade	Minnesota	Biwabik	do	103,340
138	[a]	[a]	[a]	[a]	101,299
139	Hillcrest	Minnesota	Ironton	Hematite	101,062
	Total (139 mines)				64,772,288
	Output of 36 mines producing between 50,000 and 100,000 gross tons each				2,701,670
	Output of 134 mines producing less than 50,000 gross tons each				1,877,484
	Grand total of United States (309 mines)				69,351,442

[a] Geological Survey not at liberty to publish identification.

STOCKS OF IRON ORE AT MINES

According to the reports of producers the total quantity of iron ore in stock at the mines at the end of 1923 amounted to 10,165,875 gross tons, compared with 10,524,279 tons at the end of 1922, a decrease of 3 per cent. As the quantity of ore in stock piles is of necessity partly estimated, there are variations in the mine reports from year to year which prevent an absolute balance between the quantity mined, the quantity shipped, and the stocks on hand. The reported stocks at the end of 1923 were about 1,300,000 tons below the average for the preceding five years.

Stock of iron ore at mines, by States, December 31, 1922 and 1923, in gross tons

State	1922	1923	State	1922	1923
Alabama	443, 779	304, 262	New Jersey	204, 080	145, 595
Georgia	120	155	New York	683, 223	498, 901
Idaho	175		Pennsylvania	3, 069	4, 408
Iowa	12, 165	12, 165	Virginia	62, 441	10, 022
Michigan	6, 061, 403	6, 279, 090	Wisconsin	297, 628	256, 319
Minnesota	2, 750, 916	2, 651, 879			
Missouri	5, 280	3, 079		10, 524, 279	10, 165, 875

PRICES OF IRON ORE PER TON

In the following table the average selling price at the mines of the different classes of iron ore in 1922 and 1923 is given for each of the producing States or groups of States, except where there were less than three shippers of a certain variety of ore in a State and permission was not given to publish the prices. These figures are taken directly from statements of the producers and probably represent the selling prices only approximately, as all the reports are not consistent: some of them evidently include merely mining costs; others contain, in addition, the cost of selling and insuring the ore; in others an allowance for sinking fund is included; and in still others the figures given are the costs charged against the blast furnaces. None of the reports, however, are supposed to include cost of freight.

The second following table summarizes the average prices of iron ore at mines beginning with 1912. Not until 1917 did the average price rise above $3 a ton, and the average for 1923, $3.45, is the third highest on record.

Average price per gross ton of iron ore at mines in the United States in 1922 and 1923

State	Hematite		Brown ore		Magnetite	
	1922	1923	1922	1923	1922	1923
Alabama	$1.54	$2.16	$2.55	$2.89		
California					$5.89	$6.74
Georgia	(a)	(a)	2.71	2.66		
Michigan	3.49	3.85				
Minnesota	3.27	3.55			(a)	(a)
Missouri	4.22	(a)	3.35	3.23		
Montana	(b)	(b)	[b] 2.74	[b] 2.88		
New Jersey				(a)	4.43	4.31
New York					5.49	4.49
North Carolina			2.27	2.46	(a)	(a)
Pennsylvania			(a)	(a)	1.30	2.28
Tennessee	(a)	(a)	2.77	2.86		
Virginia	(a)	(a)	3.98	3.27		
Wisconsin	3.09	2.91			(a)	(a)
Other States [c]	1.26	1.48	3.74	2.63	2.25	2.39
	3.14	3.46	2.65	2.88	2.37	3.34

[a] Less than three producers and permission to publish not given, therefore price may not be shown.
[b] Value for hematite included with brown ore.
[c] 1922: Colorado, Idaho, Massachusetts, Nevada, New Mexico, Utah, and Wyoming; 1923: Colorado, Idaho, Nevada, New Mexico, Utah, and Wyoming.

Average price per gross ton of iron ore in the United States, 1912–1923

Year	Hematite	Brown ore	Magnetite	Carbonate	General average [a]
1912	$1.87	$1.79	$2.18	$1.96	$1.88
1913	2.21	1.88	2.07	2.06	2.19
1914	1.79	1.72	2.39	2.44	1.81
1915	1.80	1.80	2.50	2.44	1.83
1916	2.32	2.03	3.11	3.00	2.34
1917	3.12	2.95	4.29		3.15
1918	3.35	3.51	4.60		3.39
1919	3.48	3.63	4.08		3.50
1920	4.09	4.19	4.59	(b)	4.11
1921	3.37	2.63	3.61	(b)	3.37
1922	3.14	2.65	2.37	(b)	3.12
1923	3.46	2.88	3.34	(b)	3.45

[a] Average prices in 1889 and 1892–1911 are given in Mineral Resources for 1919 and many earlier volumes.
[b] Sold for paint and not included in shipments of iron ore.

LAKE SUPERIOR DISTRICT

PRODUCTION

The total quantity of ore mined in the Lake Superior district, not including the Iron Ridge area in Wisconsin, increased 49 per cent in 1923. The output of the several ranges is shown below. After 1905 all manganiferous iron ore containing more than 5 per cent of manganese is excluded; the production of ore of this class amounted to 1,330,640 gross tons in 1923. The Mesabi range produced nearly 71 per cent of the output of the Lake Superior district and 60 per cent of the total output of the United States in 1923. The proportion from this range has been maintained with remarkable uniformity since 1915 and was slightly above the average in 1922 and 1923. There were increases in production in all the iron ranges; the increase in the Mesabi range was the largest and that in the Vermilion range the smallest.

Iron ore mined in the Lake Superior district, 1854–1923, in gross tons

[Exclusive after 1905 of ore containing 5 per cent or more of manganese]

Year	Marquette	Menominee	Gogebic	Vermilion	Mesabi	Cuyuna	Total
1854–1870	3,971,716						3,971,716
1871–1880	10,294,047	858,810					11,152,857
1881–1890	18,598,012	11,917,416	8,657,807	3,260,426			42,433,661
1891–1900	27,269,545	21,639,872	23,361,043	12,097,048	32,282,873		116,650,381
1901–1910	37,728,143	41,974,789	34,514,899	15,350,581	194,654,902		324,223,314
1911–1915	18,404,620	21,862,454	21,366,821	7,234,387	142,721,213	3,191,627	214,781,122
1916	4,792,987	6,649,578	7,707,101	1,704,440	41,325,341	1,555,641	63,735,088
1917	4,638,374	6,366,483	7,881,232	1,481,301	41,127,323	1,986,608	63,481,321
1918	3,946,554	6,041,637	7,837,634	1,192,677	39,055,977	1,705,315	59,779,794
1919	4,158,751	4,863,968	7,368,994	1,051,795	33,262,954	1,685,877	52,392,339
1920	4,457,609	5,651,542	8,298,206	1,053,518	36,641,880	1,757,775	57,860,530
1921	2,204,114	2,147,569	3,135,477	981,576	16,380,190	449,559	25,298,485
1922	2,745,626	3,290,641	4,910,789	1,108,764	26,704,601	955,595	39,716,016
1923	3,910,909	4,913,541	6,112,662	1,119,113	41,809,018	1,420,165	59,285,408
	147,121,007	138,178,300	141,152,665	47,635,626	645,966,272	14,708,162	1,134,762,032

SHIPMENTS AND RECEIPTS

According to the Iron Trade Review, 60,780,003 gross tons of iron ore and manganiferous iron ore was shipped in 1923 from the Lake Superior district, including the Iron Ridge and Baraboo areas in Wisconsin, as compared with 43,990,096 tons in 1922. The shipments as reported to the Geological Survey amounted to 59,453,026 gross tons of iron ore and 1,330,640 gross tons of manganiferous iron ore containing 5 per cent or more of manganese, a total of 60,783,666 tons, compared with 43,461,901 tons of iron ore and 566,157 tons of manganiferous iron ore, a total of 44,028,058 tons, in 1922.

The iron ore received at Lake Erie ports amounted to 44,568,186 gross tons and at Lake Michigan ports 12,773,711 gross tons, a total of 57,341,897 tons, compared with 32,518,784 tons at Lake Erie ports and 9,089,457 tons at Lake Michigan ports, a total of 41,608,241 tons, in 1922. Detailed figures of shipments and receipts by ports and by months for recent years will be found in the Marine Review.

STOCKS OF IRON ORE AT LAKE ERIE PORTS

Stocks of iron ore at lower Lake ports at the end of the shipping season are of importance on account of their bearing on the manufacture of pig iron during the following winter and spring. At the close of navigation in 1923 there was 8,798,127 gross tons of ore in stock at Lake Erie ports, compared with 10,635,908 tons at the corresponding date in 1922.[4] At the opening of navigation in May, 1924, there was 4,799,572 gross tons of ore in stock at these ports, indicating a withdrawal of nearly 4,000,000 tons during the winter of 1923–24. The average quantity withdrawn each winter during the preceding five winters was about 3,947,000 tons. Detailed statistics concerning these stocks by ports will be found in the Marine Review.

PRICES OF LAKE SUPERIOR IRON ORE

The value of iron ore per unit of iron in the natural state for the four standard grades of Lake Superior ore for the last 23 years is shown in the Iron Trade Review.[5] The base of old-range and

[4] Marine Review.
[5] Iron Trade Rev., March 29, 1923, p. 932.

Mesabi Bessemer ore is a metallic iron content of 55 per cent, natural, and for the old-range and Mesabi non-Bessemer ore 51.5 per cent, natural. The values established March 24, 1923, are as follows: Old-range Bessemer, 12.818 cents; Mesabi Bessemer, 12.364 cents; old-range non-Bessemer, 12.233 cents; Mesabi non-Bessemer, 11.942 cents. The prices per ton that correspond to these unit prices are, respectively, $6.45, $6.20, $5.70, and $5.55 and are 50 cents higher than the prices prevailing during the shipping season of 1922 and $1 lower than the prices in 1920, which were the highest on record. The lowest prices ever quoted for these ores were $2.60 for old-range Bessemer in 1897, $2.15 for Mesabi Bessemer in 1895, $1.85 for old-range non-Bessemer in 1898, and $1.75 for Mesabi non-Bessemer in 1898.

IRON-ORE RESERVES

Estimates of ore reserves for Minnesota, furnished by the Minnesota Tax Commission, and for Michigan, furnished by the Michigan Board of State Tax Commissioners, including developed and prospective ore in the ground and ore in stock piles, show an increase of nearly 15,000,000 gross tons in Minnesota and a decrease of nearly 5,000,000 tons in Michigan. The Mesabi and Cuyuna ranges in Minnesota and the Menominee range in Michigan each showed increases in 1923.

Iron-ore reserves in Minnesota May 1, 1920–1923, in gross tons

Range	1920	1921	1922	1923
Mesabi	1,305,926,735	1,273,128,664	1,252,820,242	1,254,861,451
Vermilion	10,927,844	13,201,525	14,354,328	13,688,352
Cuyuna	24,819,959	25,080,590	29,485,159	43,041,100
	1,341,674,538	1,311,410,779	1,296,659,729	1,311,590,903

Iron-ore reserves in Michigan January 1, 1921–1924, in gross tons

Range	1921	1922	1923	1924
Gogebic	64,964,666	62,405,146	58,314,512	54,949,558
Marquette	73,853,786	72,953,551	72,102,521	70,384,149
Menominee (including Iron River and Crystal Falls districts)	65,311,868	64,386,025	66,409,915	66,555,393
	204,130,320	199,744,722	196,826,948	191,889,100

MINING DEVELOPMENTS

LAKE SUPERIOR DISTRICT [6]

General conditions.—During 1923 there was a continuation of the development of better methods of mining and handling ore, both surface and underground, and of transporting it from the ranges to the docks. Beneficiation methods were improved and the capacity enlarged by the addition of crushing and screening plants. Transportation was more efficient than in the last several years, and

[6] Woodbridge, D. E., Intensive production of Lake Superior ore: Iron Age, Jan. 3, 1924, pp, 74–76. Hain, A. J., Progress in iron-ore trade reflects prosperity: Iron Trade Review, Jan. 3, 1924, pp. 45–49. Woodbridge, D. E., Iron mining: Eng. and Min. Jour.-Press, Jan. 19, 1924, p. 88.

although Lake shipments were late in beginning and early in closing, a very satisfactory quantity was handled by water, aggregating 59,036,704 tons of iron ore and manganiferous iron ore. This is the third largest quantity handled in a single season. A large amount of new equipment, including steam shovels, mine locomotives, and cars, was bought for some of the larger open-pit mines.

Exploration work and stripping were heaviest in the vicinity of existing mines, but search for new ore deposits not adjacent to mines was not as active in Minnesota as in former years on account of the high taxation, which compels prompt mining and rapid exhaustion of the ore. Considerable dissatisfaction is being shown by operators of mining properties in Minnesota who believe that an effort is being made to impose confiscatory taxation so that private ownership will be relinquished, with the result that natural resources may be taken over by the State. Many properties on which for long periods royalties and taxes had been paid have now been abandoned and have reverted to the original owners and some of them to the State. The large operator who can absorb the high tax in general costs or add it to the price of manufactured products and who can exhaust individual mines quickly fares better under this policy than the small holder of undeveloped mineral land. In Michigan, however, exploration was more active, and in Ontario exploration seems to have been encouraged by the prospect of a Government bounty on iron ores mined in the Provinces.

Mesabi range.—The activity in mining on the Mesabi range is shown by the increase in production of 57 per cent. The production in 1923 amounted to about 130 per cent of the average for the preceding 10 years. Notwithstanding the increased mining activity, exploration does not seem to have been pushed vigorously, although the new ore discovered during the year was more than sufficient to keep pace with production. Near certain of the mines drilling was done in order to prove the existence of ore already believed to be present, and there were several stripping operations and a few shafts were sunk. Shipments of ore were made from the new Harrison Annex and Little & Prindle mines. The Sweeney mine, at Hibbing, was reported to have been exhausted during 1923. The outstanding development on the Mesabi range in 1923 as well as in 1922 may be said to have been the operations of the Mesabi Iron Co. at Babbitt. These developments have been described in detail by Parsons,[7] and it will not be necessary to discuss them here further than to state that enormous quantities of low-grade ore have been proved, the feasibility of concentrating the ore by the methods in use has been established, and now it remains to increase the capacity of the plant to such a point that quantity production will reduce cost to a figure that will permit the concentrates to be marketed at a profit. Apparently the experience of the company up to the end of 1923 indicated that output was limited by the capacity of the sintering machine, which had a nominal production of 400 tons of sinter a day, whereas the crushing and grinding departments could supply material equivalent to 800 tons of sinter. In 1924 the plant was

[7] Parsons, A. B., Operations of the Mesabi Iron Co. the outstanding development of the Lake Superior region: Eng. and Min. Jour.-Press, Jan. 26, 1924, pp. 157–164; Feb. 2, 1924, pp. 202–210.

reported to have been shut down in order to increase the capacity for sintering and otherwise balance the fine grinding and concentrating department in its relation to the sintering end.

Vermilion range.—Mines on the Vermilion range had a fair season in 1923 and increased their production 1 per cent; the output was about 86 per cent of the average for the preceding 10 years. Exploration did not keep pace with production. Additional work was done in the installation of electric hoists and electrification of mines, concreting shafts, and building overhead trestles. At one of the large mines modern houses for the miners and sewers and water lines were built. The labor situation was reported as satisfactory on the Vermilion range, and the use of mechanical scrapers and loaders has helped increase the output of ore per miner. One mine that had been practically inactive during 1922 made shipments of siliceous ore from old rock stock piles, presumably for the manufacture of ferrosilicon.

Cuyuna range.—The production of iron ore containing less than 5 per cent of manganese on the Cuyuna range increased 49 per cent in 1923, and the output was about 111 per cent of the average of the 10 preceding years. Some exploration work was carried on as a continuation of work begun in 1922, and a large amount of stripping was done. There has been a renewed interest in the manganiferous iron ore of the Cuyuna district, which is coming more and more into use in the manufacture of high-manganese pig iron and spiegeleisen, and at one of the large mines in the district stripping continued throughout the year and the crushing, drying, and screening plant was enlarged. The ore reserves credited to the Cuyuna range apparently increased more than 13,500,000 tons over those for 1922, or nearly the whole increase for the State. This, however, does not represent newly discovered ore but ore of certain grades that has been reinstated on the tax list after having been taken off in the period of depression following the World War.

Marquette range.—The production of ore on the Marquette range increased 42 per cent in 1923 and was about 103 per cent of the average for the preceding 10 years. The estimated ore reserves showed a decrease of about 1,718,000 tons at the end of the year, thus indicating that new discoveries did not keep pace with production. The Ford Motor Co. has been conducting a thorough exploration for ore on lands which heretofore had been explored only in a superficial manner. The results during 1923 were reported as negative, but inasmuch as this company's requirements for ore are much greater than its production and as it has its own equipment for carrying its own ore down the lakes, no doubt it will eventually obtain by development or purchase a sufficient reserve of ore. The Barnes-Hecker mine made its initial shipment in 1923.

Gogebic range.—The production on the Gogebic range increased about 24 per cent in 1923 and was about 99 per cent of the average of the preceding 10 years. In the Michigan portion of the range the estimated ore reserves showed a decrease of nearly 3,365,000 tons. Extensive developments have been under way in the large mines of this range, and a small-scale magnetic separator has been installed to handle a fine-grained hard ore that is a mixture of magnetite and hematite.

Menominee range.—The production of ore on the Memoninee range increased 49 per cent and was about 102 per cent of the average for the preceding 10 years. In the Michigan portion of the range the estimated reserves of ore increased slightly. The Buck mine was a new shipper in 1923. All the machinery and equipment at the Clifford mine, at Iron Mountain, was moved away and the mine abandoned in 1923.

MISSOURI

An effort is being made to revive the once famous Iron Mountain district of southeastern Missouri as a producer of iron ore, and shipments are going to the blast furnace at Granite City, Ill. A concentrating plant has been installed, and much prospecting has been done by means of shaft and drills, so that there are indications that this district will once again become an important ore producer. Limonite ores in Wayne and other counties of southeastern Missouri were examined with a view to increasing the shipments of these ores for local consumption. There is a market for all the ore that can be produced locally, inasmuch as the St. Louis district is already consuming considerable ore that is shipped in by rail from the Lake Superior district and from the Baraboo district of southern Wisconsin. An increase in the production of iron and steel in the St. Louis district is expected in view of its central location and the possibility of coking southern Illinois coal. In view of this situation the brown iron ore of northeastern Texas should possibly find a market in the St. Louis district.

SOUTHEASTERN STATES

The activity in iron-ore mining in Birmingham, Chattanooga, and other districts in Alabama, Tennessee, North Carolina, and Georgia is shown in increases in 1923 ranging from 30 per cent in Alabama to 386 per cent in Georgia. Probably the most important change in mining methods that has been reported from this region was the introduction of mechanical loading devices in some of the underground red-ore mines of the Birmingham district. It is understood that these devices, which have not yet been described in the technical press, have proved successful in increasing the output of ore. Laboratory studies begun by the Bureau of Mines in 1921 have been continued, and the metallurgical laboratory at the Tuscaloosa experiment station has been specially equipped for studies of concentration of the high-silica red ores.

NORTHEASTERN STATES

Adirondack district.—The Adirondack district showed an increase of 13 per cent in production of iron ore in 1923. The output was small, however, being only about 59 per cent of the average for the preceding 10 years and less than one-half of the capacity of the operating companies. Only three mines of seven at Mineville and one mine at Lyon Mountain were in operation. Mechanical shovels are in use underground at one mine. A sintering plant made its initial run in November, 1923, at the Port Henry blast furnaces. Most of the ore mined in this district is concentrated magnetically, but a portion is shipped direct as mined.

WESTERN STATES

Utah.—The plans for the development of deposits of iron ore in the Iron Springs district, Utah, that have been under way for several years were finally consummated through the completion of the branch of the Los Angeles & Salt Lake Railroad from Lund to Cedar City. A spur track was extended from the branch line, one portion of it to the deposits of iron ore near Iron Springs, the other to the west end of Desert Mound. The Columbia Steel Corporation has opened the deposits in the foothills nearest Iron Springs by means of tunnels and glory holes and has installed loading trestles and crushers so that ore ready for shipment is delivered directly into railroad cars. During 1923 ore was shipped from this mine to points in Utah for smelter flux, but by the middle of 1924 the production of ore destined for the blast furnace that the Columbia Steel Corporation has erected at Provo, Utah, was well under way. Further comment on the production of this ore for the manufacture of pig iron and of ore from the Desert Mound deposit for smelter flux will be in order in the reports on developments in 1924.

FOREIGN TRADE IN IRON ORE

IMPORTS AND EXPORTS

The iron ore imported into the United States in 1923 increased 144 per cent in quantity and 130 per cent in value, as compared with 1922. The average value was $4.08 a ton in 1923 and $4.33 in 1922. Sweden contributed 27 per cent of the ore imported, Cuba 25 per cent, and Chile 23 per cent. The accompanying diagram (fig. 15) indicates the source and district of entry of the iron ore imported into the United States.

Iron ore imported into the United States, 1921–1923

Country	1921		1922		1923	
	Gross tons	Value	Gross tons	Value	Gross tons	Value
Algeria and Tunis	8,336	$25,304	115,571	$330,182	345,367	$1,075,289
Other French Africa			5,000	14,484		
Belgium	436	1,814				
Brazil					70	262
Canada	4,213	15,667	2,840	10,439	24,679	93,934
Chile	8,000	30,000	259,547	1,625,332	634,600	3,704,159
China	417	19,169	(a)	2	2,968	8,809
Colombia					19,000	76,000
Cuba	123,222	493,092	381,746	1,580,504	692,979	2,780,131
Egypt	6,000	17,922	885	23,685	13,000	92,233
France	1,012	4,935			128	2,741
Germany	744	4,023	2,906	14,709	16,013	80,919
Greece					15,300	23,339
Hongkong			1	58		
Italy					1	5
Kwangtung	40	218	24	79	1	15
Morocco	14,360	57,912				
Newfoundland and Labrador			1	5	33,240	120,119
Netherlands					1,067	5,425
Norway					4,931	32,559
Spain	5,602	17,427	47,111	242,783	214,891	503,258
Sweden	143,234	384,283	317,539	1,054,992	749,765	2,695,612
United Kingdom	152	4,143	580	13,142	399	9,928
Venezuela			1,400	5,838		
Virgin Islands of the United States			5	60		
	315,768	1,075,909	1,135,156	4,916,294	2,768,399	11,304,737

(a) Less than 1 ton.

Iron ore imported into the United States, 1872–1923

Year	Gross tons	Year	Gross tons	Year	Gross tons
1872–1880	1, 188, 267	1916	1, 325, 736	1921	315, 768
1881–1890	7, 663, 630	1917	971, 663	1922	1, 135, 156
1891–1900	5, 869, 757	1918	787, 468	1923	2, 768, 399
1901–1910	11, 798, 568	1919	476, 461		44, 777, 276
1911–1915	9, 202, 947	1920	1, 273, 456		

The iron ore exported from the United States in 1923 amounted to 1,116,932 gross tons, valued at $5,305,365, or $4.75 a ton, compared with 602,194 tons, valued at $2,770,878, or $4.60 a ton, in 1922. The exports represent an increase of 85 per cent in quantity and 91 per cent in value. With the exception of 47 tons to Belgium and 53 tons to Scotland, all the ore exported in 1923 went to Canada.

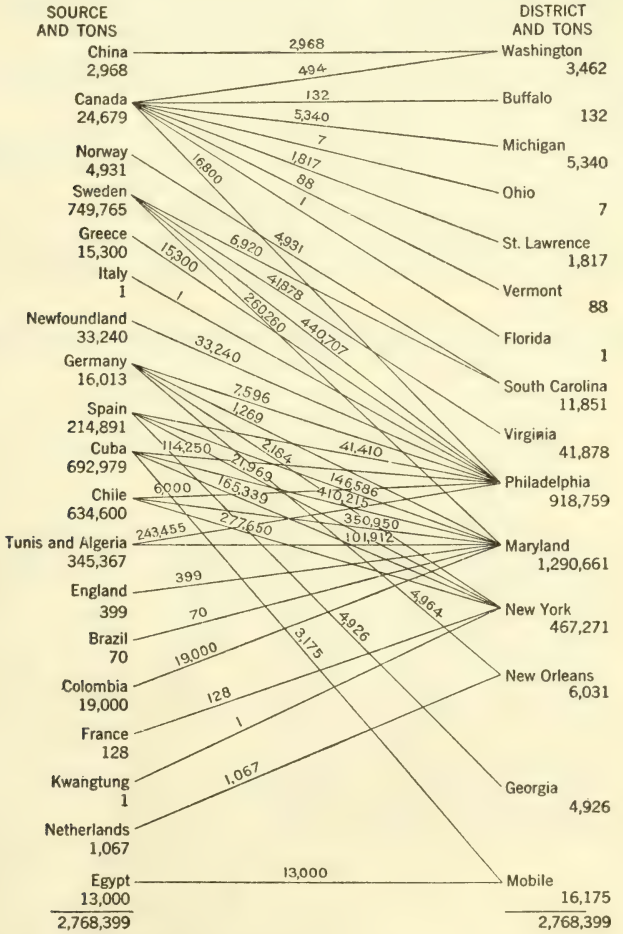

FIGURE 15.—Source and district of entry of iron ore imported into the United States in 1923

Iron ore exported from the United States, 1899–1923, in gross tons

Year	Quantity	Year	Quantity
1899–1900	92, 125	1920	1, 145, 037
1901–1910	2, 713, 397	1921	440, 106
1911–1915	4, 265, 538	1922	602, 194
1916	1, 183, 952	1923	1, 116, 932
1917	1, 132, 313		
1918	1, 256, 383		14, 944, 546
1919	996, 569		

IRON-ORE MINING IN CUBA

The iron ore shipped from Cuba to the United States in 1923 amounted to 674,371 gross tons, valued at $2,737,946, compared with 444,794 tons, valued at $1,416,098, in 1922, and showed an increase in quantity of 52 per cent and in value of 93 per cent. The average price of the ore was $4.06 a ton in 1923; in 1922 it was $3.18. The shipments in 1923 consisted of hematite and a little magnetite from the Daiquiri and Juragua mines, on the southern coast. The Mayari mines, near the northern coast, were nonproductive. In 1923 the iron content of the hematite, dried at 212° F., was reported at 58.31 per cent; in 1922 it averaged 58.58 per cent.

The total stock of ore (natural and nodulized) reported as on hand at the end of 1923 was 773,390 gross tons, compared with 965,485 tons at the end of 1922, a decrease of 20 per cent.

The following table shows the shipments of iron ore from Cuba since the opening of the mines in 1884. The statistics of the shipments of Cuban iron ore are collected by the United States Geological Survey.

Iron ore shipped from mines in the Province of Oriente, Cuba, 1884–1923, in gross tons

Year	Juragua (hematite and magnetite)	Sigua (hematite)	Daiquiri (hematite and a little magnetite)	Mayari (brown ore)	Guamá (hematite)	El Cuero (hematite)	Total
1884–1890	1, 142, 519						1, 142, 519
1891–1900	[a] 2, 348, 473	20, 438	[b] 979, 992				3, 348, 903
1901–1910	2, 104, 186		[c] 4, 456, 440	307, 700	41, 241	224, 729	7, 134, 296
1911–1915	1, 567, 112		1, 837, 669	1, 855, 525		532, 194	5, 792, 500
1916	212, 013		181, 602	258, 451		60, 650	712, 716
1917	39, 784		181, 028	287, 904		44, 769	553, 485
1918	17, 128		353, 103	232, 540		40, 761	643, 532
1919			279, 700	78, 080			357, 780
1920	[d]		[d] 561, 268	321, 515			882, 783
1921	[d]		[d] 130, 359				130, 359
1922	[d]		[d] 444, 794				444, 794
1923	[d]		[d] 674, 371				674, 371
	[d] 7, 431, 215	20, 438	[d] 10, 080, 326	3, 341, 715	41, 241	903, 103	21, 818, 038

[a] Of this quantity, 5,932 tons was sent to Pictou, Nova Scotia.
[b] Of this quantity, 51,537 tons was sent to ports outside of the United States.
[c] Of this quantity, 12,691 tons was sent to ports outside of the United States.
[d] Shipments of Juragua mines, 1920–1923, included with Daiquiri mines.

PRODUCTION OF IRON ORE, BY COUNTRIES

The following table, compiled by W. I. Whiteside, of the Geological Survey, shows the production of iron ore by countries for 1920 to 1923, as far as it has been possible to obtain figures. For preceding years see earlier volumes of Mineral Resources.

Iron ore produced, 1920–1923, by countries, in metric tons

Country	1920	1921	1922	1923	Source of data [a]
North America:					
Canada [b]	117,092	53,985	5,315	27,898	1920, 1; 1921–1923, 2.
Cuba [b]	896,952	132,451	451,933	685,195	1920–1923, 3.
Newfoundland [b]	590,850	522,456	1,100,000	1,200,000	1920, 1; 1921, 4; 1922–1923, 5.
United States	68,689,517	29,964,308	47,884,940	70,464,533	1920–1923, 3.
South America:					
Brazil (exports)	17			350	1920–1923, 6.
Chile [d]		48,393	222,947	679,187	1920–1923, 7.
Europe:					
Austria	435,062	710,932	1,112,415	1,211,065	1920–1922, 8; 1923, 9.
Belgium	17,260	38,300	63,200	87,480	1920–1923, 10.
Czechoslovakia	1,053,124	800,829	313,149	(c)	1920–1922, 11.
Finland	12,893		1,187	(c)	1920–1922, 12.
France	13,921,800	14,200,937	21,106,000	23,428,160	1920–1921, 13; 1922–1923, 14.
Germany	6,354,344	5,903,190	(c)	(c)	1920–1921, 15.
Greece	45,579	54,925	49,272	100,115	1920–1922, 17; 1923, 18.
Hungary	101,665	36,015	45,909	(c)	1920–1922, 19.
Italy	389,876	279,478	311,214	340,831	1920–1922, 20; 1923, 21.
Luxemburg	3,704,390	3,031,626	4,488,974	4,097,549	1920–1923, 22.
Norway	79,208	54,975	268,815	(c)	1920–1922, 23.
Poland	120,000	241,293	352,531	450,175	1920–1923, 24.
Portugal	12,845	10,370	(c)	(c)	1920–1921. 26.
Rumania [e]	79,839	91,109	94,607	99,293	1920–1923, 27.
Russia	170,356	170,356	220,775	(c)	1920–1922, 28.
Spain	4,767,693	2,602,369	2,771,888	3,456,233	1920–1923, 29.
Sweden	4,519,112	6,464,347	6,201,243	5,597,707	1920–1922, 30; 1923, 31.
Switzerland	(c)	28,000	47,000	(c)	1921–1922, 32.
United Kingdom	12,910,840	3,533,776	6,977,736	11,049,758	1920, 33; 1921–1923, 34.
Yugoslavia	1,130	16,357	35,645	244,619	1920–1923, 36.
Asia:					
China	1,489,731	1,270,000	(c)	(c)	1920–1921, 37.
Chosen	454,427	242,225	185,560	243,279	1920, 38; 1921–1923, 39.
India	566,961	957,204	635,310	817,294	1920–1923, 40.
Indo-China	2,376		(c)	(c)	1920–1921, 13.
Japan	203,559	19,935	(c)	(c)	1920–1921, 41.
Unfederated Malay States		75,442	113,154	156,635	1920–1923, 42.
Africa:					
Algeria	1,071,278	720,840	1,045,816	1,452,563	1920–1923, 43.
Belgian Congo	79,732	73,215	71,305	(c)	1920–1922, 44.
Madagascar	34	44	24	(c)	1920–1922, 45.
Morocco	211,886	[f] 115,457	300,084	396,705	1920–1921, 45 [a]; 1922–1923, 45 [b].
Tunis	406,280	265,736	496,762	845,000	1920–1923, 46.
Union of South Africa	2,326	2,192	1,913	521	1920–1923, 47.
Oceania:					
Australia—					
New South Wales [g]	165,820	181,839	115,152	181,309	1920–1923, 48.
Queensland	20,025	4,126		203	1920–1923, 49.
South Australia	419,667	515,130	52,248	390,604	1920–1923, 51.

[a] 1, Canada Dept. Mines, Mines Branch; 2, Dominion Bur. Statistics; 3, U. S. Geol. Survey; 4, data furnished by Deputy Minister, Dept. Agr.; 5, Iron and Coal Trades Rev.; 6, Commercio exterior do Brasil; 7, Bethlehem-Chile Iron Mines Co.; 8, Mitteilungen über den oesterreichischen Bergbau; 9, data furnished by Bundesmin. f. Handel u. Verkehr.; 10, Statistique des industries extractives et métallurgiques; 11, State Statistical Office Rept.; 12, U. S. consul, Helsingfors, Oct. 23, 1923; 13, Statistique de l'industrie minérale en France et en Algérie; 14, data furnished by Direction des mines, Ministère des travaux publics, Paris; 15, Vierteljahrshefte zur Statistik des Deutschen Reichs; 17, Tableau statistique du mouvement minier; 18, data furnished by Direction du Service des mines, Athens; 19, Royal Hungarian Ministry of Foreign Affairs; 20, Rivista del servizio minerario; 21, data furnished by Ministry of National Economy, Rome; 22, U. S. consul general, Rotterdam; 23, Bergverksdrift, Norges Offisielle Statistikk; 24, Polish Government through U. S. legation, Warsaw; 26, U. S. consul general, Lisbon; 27, Statistique minière de la Roumanie; 28, Commerce Repts.; 29, Estadística minera de España; 30, Sveriges officiella Statistik, Bergshantering; 31, Skillings Min. Rev.; 32, consular report, June 10, 1923; 33, Mines and Quarries, London; 34, Sec. Mines and H. M. Chief Insp. Mines Ann. Rept.; 36, Royal Ministry of Forests and Mines, through U. S. minister; 37, Director of the Geological Survey of China, through U. S. consul general at Tientsin; 38, U. S. embassy, Tokyo; 39, U. S. consul, Keijo; 40, India Geol. Survey Records; 41, Mining industry of Japan; 42, Warden of Mines, Johore; 43, Bur. Mines, Gov. Gen. of Algeria; 44, Union minière du Haut-Katanga; 45, Madagascar, Service des mines; 45 [a], Imp. Mineral Resources Bur., London; 45 [b], Min. Jour., London, Mar. 29, 1924; 46, Direction générale des travaux publics, Service des mines; 47, Dept. Mines and Industries Ann. Rept.; 48, Dept. Mines Ann. Repts.; 49, Under Sec. Mines Ann. Repts.; 51, Review of mining operations, Dept. Mines.

[b] Shipments.

[c] Data not available.

[d] From Tofo mine.

[e] Fiscal year Apr. 1 to Mar. 31.

[f] Exports from Melilla.

[g] Includes iron oxide used for paint and ironstone.

BENEFICIATED IRON ORE

The processes reported as employed in 1923 to improve the quality of the ore at mines were crushing and screening, drying by direct heat and by steam, hand picking on tables and on belts, washing by means of hydraulic jets and logs, jigging, electromagnetic separation, sintering, calcining, nodulizing, and desulphurization by sintering. Some of the operations combined two or more of these processes. Iron ores were reported as beneficiated at 90 mines in 12 States in 1923 and at 83 mines in 12 States in 1922. Some iron ore is also recovered in the form of dust from blast furnaces, but no statistics have been gathered on this subject. Ore so recovered has been originally accounted for in the statistics of shipments from the mines.

The total beneficiated ore reported as shipped from mines in the United States in 1923 increased 61 per cent in quantity and 73 per cent in value, as compared with 1922. From such figures as are available to show the relation between crude ore treated and beneficiated ore recovered it is apparent that in washing brown ore the ratios, by weight, of crude ore washed to resultant concentrates are from 7:1 to 1.25:1, in concentrating hematite from 2.852:1 to 1.045:1, in magnetite from 3.458:1 to 1.073:1, and in carbonate 1.333:1.

Beneficiated iron ore shipped from mines in the United States, 1922–23

State	Variety	1922		1923	
		Gross tons	Value	Gross tons	Value
Alabama	Hematite, brown ore	803, 369	$2, 133, 695	1, 003, 247	$2, 938, 692
Georgia	Brown ore	21, 558	53, 933	89, 584	238, 591
Massachusetts	do	4, 368	(a)		
Michigan	Hematite	150, 566	(a)	56, 445	(a)
Minnesota	Hematite, magnetite	4, 621, 202	14, 792, 449	7, 571, 939	25, 690, 872
Missouri	do	35, 823	(a)	28, 674	136, 825
New Jersey	Magnetite, brown ore	90, 374	400, 356	309, 252	1, 332, 398
New York	Magnetite	175, 317	996, 137	656, 192	2, 971, 996
North Carolina	Brown ore	14, 958	33, 914	11, 399	(a)
Pennsylvania	Magnetite, brown ore	559, 109	2, 107, 480	626, 392	(a)
Tennessee	Hematite, brown ore	133, 026	343, 470	202, 553	501, 834
Virginia	do	12, 278	57, 017	129, 229	483, 274
Wisconsin	Magnetite	1, 196	(a)	2, 086	(a)
Undistributed			688, 792		3, 071, 029
		6, 623, 144	21, 607, 243	10, 686, 992	37, 365, 511

a Included under "Undistributed."

IRON AND STEEL

The records of the production and sales of iron and steel shown in the following pages are derived in part from producers who report directly to the United States Geological Survey and in part from several other authoritative sources, such as the American Iron and Steel Institute, Metal Statistics, the Iron Age, the Iron Trade Review, and the Bureau of Foreign and Domestic Commerce of the Department of Commerce.

PIG IRON

SHIPMENTS, VALUE, AND PRODUCTION, BY STATES

The shipments of pig iron, exclusive of ferroalloys, reported to the United States Geological Survey by the manufacturers represented an increase of 39 per cent in quantity and 56 per cent in gross value as compared with 1922. The values stated represent the approximate amounts received for the iron f. o. b. furnaces and do not include freight costs, selling commissions, and other items which are figured in some of the market prices of pig iron as published in the trade journals.

The pig iron shipped includes the metal produced from foreign as well as from domestic ore. The pig iron derived from ore imported from Africa, Algeria, Brazil, Canada, Chile, Cuba, Greece, Newfoundland, Spain, and Sweden, although it constitutes a very small percentage of the total production, amounted in 1923 to 1,178,756 gross tons, valued at $33,376,286, as compared with 649,111 tons, valued at $13,640,340, in 1922. In the manufacture in 1923 of 1,265,160 gross tons of pig iron, 2,126,458 gross tons of foreign ore, including 42,364 tons of cinder derived from foreign pyrite, was reported to have been used, thus indicating an average pig-iron yield of 59.50 per cent from imported ore. Domestic ore, including 5,334,084 gross tons of cinder, scale, and scrap and amounting to 74,606,663 gross tons, was reported as used in the manufacture of 38,502,322 tons of pig iron, thus indicating a yield of 51.61 per cent in pig iron from domestic materials. The total production of pig iron, exclusive of ferroalloys, reported to the Geological Survey was 39,767,482 gross tons, compared with 26,826,210 tons in 1922, an increase of 48 per cent.

Pig iron shipped from blast furnaces in the United States, 1922 and 1923, by States

State	1922		1923		Percentage of increase or decrease	
	Gross tons	Value	Gross tons	Value	Quantity	Value
Alabama	2,223,159	$42,883,424	2,784,625	$64,912,809	+25	+51
Colorado	(a)	(a)	(a)	(a)		
Connecticut	(a)	(a)				
Illinois	2,729,172	58,954,675	3,741,002	94,878,917	+37	+61
Indiana	2,191,356	43,064,817	3,021,504	70,270,894	+38	+63
Kentucky	140,217	2,951,627	154,680	(a)	+10	
Maryland	423,533	(a)	489,137	(a)	+15	
Massachusetts	510	(a)	1,667	(a)	+227	
Michigan	595,647	14,791,041	717,279	18,827,808	+20	+27
Minnesota	177,297	(a)	418,726	(a)	+136	
Missouri	7,700	(a)	4,513	(a)	−41	
New Jersey	88,908	(a)	(a)	(a)		
New York	1,708,605	37,783,073	2,426,522	57,543,779	+42	+52
Ohio	6,756,648	149,805,909	8,964,805	222,009,553	+33	+48
Pennsylvania	9,732,024	221,581,288	13,898,624	347,679,274	+43	+57
Tennessee	95,326	2,063,376	215,009	5,793,756	+126	+181
Virginia	31,022	793,903	238,742	6,389,149	+670	+705
West Virginia	309,944	7,537,184	506,543	12,499,112	+63	+66
Wisconsin	209,289	4,970,227	280,457	7,264,981	+34	+46
Undistributed	[b] 250,381	[b] 20,964,314	[b] 497,544	[b] 38,729,346		
	27,670,738	608,144,858	38,361,379	946,799,378	+39	+56

[a] Included under "Undistributed." [b] Includes figures for States marked "(a)".

Pig iron shipped from blast furnaces in the United States in 1922 and 1923, by grades

Grade	1922			1923		
	Gross tons	Value	Average price	Gross tons	Value	Average price
Charcoal	232,244	$6,447,924	$27.76	253,544	$7,834,835	$30.90
Foundry	3,877,201	85,587,682	22.07	5,492,429	137,330,641	25.00
Basic	14,359,461	306,257,984	21.33	19,699,027	468,716,847	23.79
Bessemer	7,723,335	175,082,881	22.67	10,993,132	281,730,764	25.63
Low-phosphorus	152,023	4,359,606	28.68	209,014	6,350,833	30.38
Malleable	1,036,786	23,521,993	22.69	1,343,370	35,338,854	26.31
Forge	211,601	5,063,516	23.93	268,217	6,802,884	25.36
All other (not ferroalloys)	78,087	1,823,272	23.35	102,646	2,693,720	26.24
	27,670,738	608,144,858	21.98	38,361,379	946,799,378	24.68

The American Iron and Steel Institute reports that the output in 1923 of all kinds of pig iron, including ferroalloys, produced in blast furnaces, as well as some that was electrically produced, increased 13,141,242 tons, or 48 per cent, as compared with 1922.

Pig iron, including ferroalloys, manufactured in the United States in 1922 and 1923, in gross tons [a]

State	1922	1923	State	1922	1923
Pennsylvania	9,731,788	14,804,620	Virginia	49,024	276,874
Ohio	6,484,162	9,347,960	Missouri	266,716	321,436
Illinois	2,625,244	3,839,063	Iowa		
Alabama	2,230,619	2,797,190	Colorado		
Indiana	2,726,727	3,813,125	Washington		
Michigan			Maryland	366,967	529,606
New York	1,772,325	2,951,810	Tennessee	123,907	250,982
New Jersey			Connecticut	1,084	1,309
Wisconsin	381,030	724,717	Massachusetts		
Minnesota					
West Virginia	460,311	702,454		27,219,904	40,361,146
Kentucky					

[a] American Iron and Steel Institute.

AVERAGE PRICES

PRICES AT BLAST FURNACES

The average prices of all kinds of pig iron given in the following table are based on reports of the manufacturers to the Geological Survey. The figures represent the approximate prices f. o. b. at the blast furnaces and do not include the prices of ferroalloys. The general average price for all grades of pig iron at the furnaces, exclusive of ferroalloys, showed an increase of 12 per cent for 1923.

Average price per gross ton of pig iron at blast furnaces in the United States, 1918–1923

State	1918	1919	1920	1921	1922	1923
Alabama	$30.58	$25.96	$32.70	$24.33	$19.29	$19.72
Illinois	30.91	24.42	28.02	24.50	21.60	25.36
Indiana	29.09	22.51	25.58	22.32	19.65	23.26
Kentucky	34.19	30.06	31.72	28.77	21.05	[a]
Michigan	35.44	32.23	36.22	29.64	24.83	26.25
Missouri	36.97	33.40	45.04	28.19	[a]	[a]
New Jersey	34.22	31.48	38.23	[a]	[a]	[a]
New York	28.27	26.84	37.02	23.15	22.11	23.71
Ohio	30.31	25.59	29.93	24.24	22.17	24.76
Pennsylvania	31.69	25.86	33.27	24.43	22.77	25.02
Tennessee	34.08	33.10	42.55	27.12	21.65	26.95
Virginia	34.00	31.53	41.21	30.24	25.59	26.76
West Virginia	[a]	25.04	32.53	25.29	24.32	24.68
Wisconsin	38.08	29.42	33.98	29.15	23.75	25.90
Other States[b]	28.52	25.92	33.87	25.50	22.11	24.73
Average for United States	30.89	25.75	31.95	24.28	21.98	24.68

[a] Included under "Other States."

[b] 1918: Colorado, Connecticut, Georgia, Maryland, Massachusetts, Minnesota, Washington, and West Virginia; 1919: Colorado, Connecticut, Maryland, Massachusetts, Minnesota, Texas, and Washington; 1920: Colorado, Connecticut, Maryland, Massachusetts, and Minnesota; 1921: Colorado, Connecticut, Maryland, Massachusetts, Minnesota, and New Jersey; 1922: Colorado, Connecticut, Maryland, Massachusetts, Minnesota, Missouri, and New Jersey; 1923: Colorado, Kentucky, Maryland, Massachusetts, Minnesota, Missouri, and New Jersey.

Average price per gross ton of pig iron at blast furnaces in the United States, 1889–1923

1889	$15.78	1898	$9.90	1907	$20.56	1916	$16.96
1890	16.43	1899	18.00	1908	15.96	1917	27.29
1891	15.50	1900	18.85	1909	16.25	1918	30.89
1892	14.32	1901	15.25	1910	15.45	1919	25.75
1893	11.90	1902	20.92	1911	14.07	1920	31.95
1894	9.76	1903	19.12	1912	13.93	1921	24.28
1895	11.14	1904	14.13	1913	15.08	1922	21.98
1896	10.47	1905	16.63	1914	13.42	1923	24.68
1897	9.85	1906	19.98	1915	13.21		

COMMERCIAL QUOTATIONS

The average monthly prices of the principal grades of pig iron, either at the blast furnaces or at the nearest market, in 1922 and 1923, according to published market quotations, are summarized in the following table for comparison with figures reported by blast-furnace operators as shown in the preceding tables. The average commercial quotations for each of the four grades of iron show an increase and are apparently higher than the average prices reported by the manufacturers, and so in comparing these prices it should be borne in mind that the manufacturers' prices represent weighted averages of what was actually received by them for the metal and that a discrepancy is to be expected between the two sets of prices. Commercial quotations of prices of basic pig iron for the last seven years are shown graphically in Figure 16. These years include the period during which the United States was involved in the World War, and the contrast between the high and low prices is shown more markedly than it would be in tabular form.

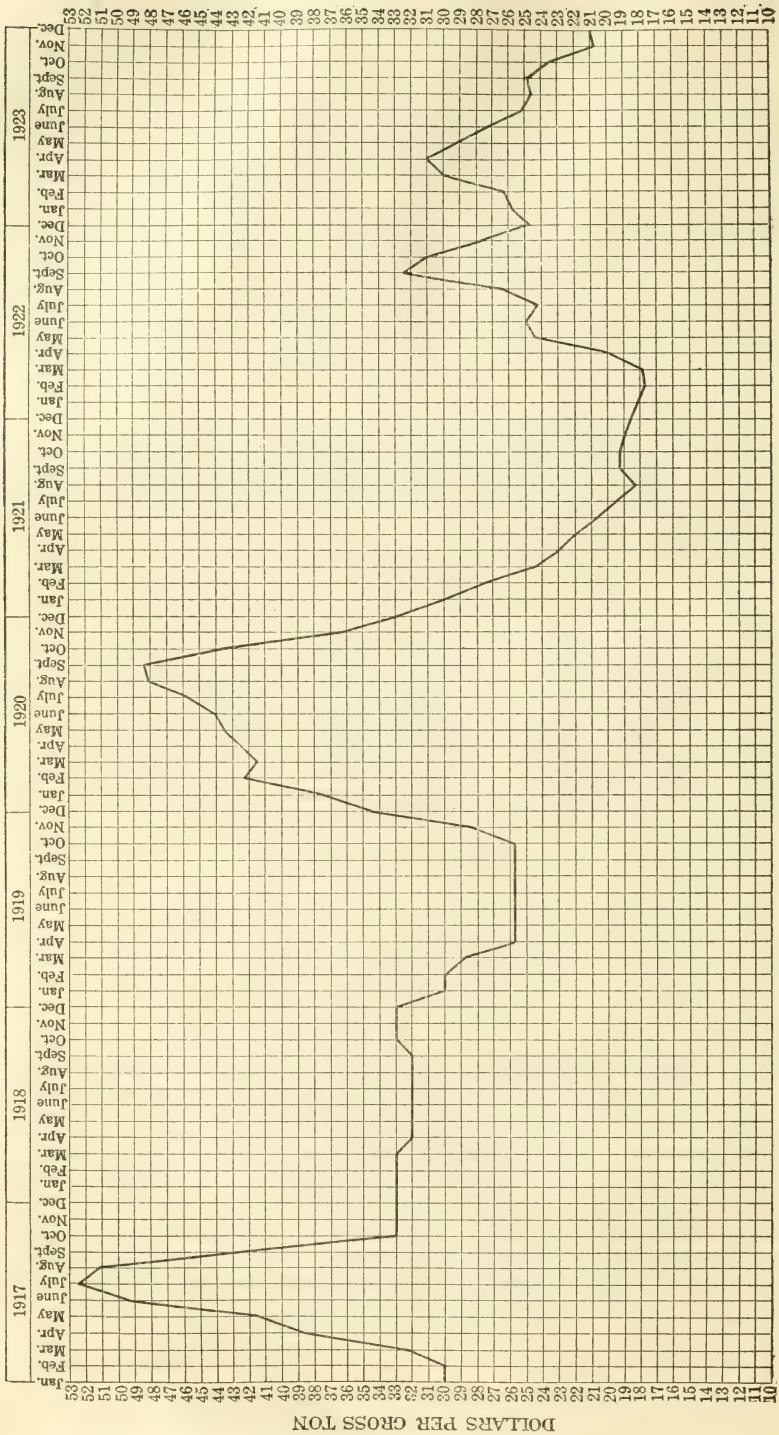

FIGURE 16.—Commercial quotations of basic pig iron at blast furnaces in Mahoning and Shenango valleys, Ohio and western Pennsylvania, 1917-1923, by months

Average monthly prices per ton of principal grades of pig iron, 1922 and 1923 [a]

Month	Foundry pig iron at Valley furnaces		Foundry pig iron at Birmingham furnaces		Bessemer pig iron at Valley furnaces		Basic pig iron at Valley furnaces	
	1922	1923	1922	1923	1922	1923	1922	1923
January	$19.38	$27.00	$15.96	$23.23	$19.62	$27.50	$18.19	$25.00
February	18.92	27.21	15.33	24.29	19.40	27.75	18.00	25.67
March	18.87	30.00	15.31	26.33	19.02	29.94	17.89	29.44
April	20.74	31.00	15.74	27.00	20.88	31.00	19.98	31.00
May	24.00	30.69	17.63	27.00	25.08	30.23	24.62	29.33
June	24.00	28.04	18.44	25.63	25.00	28.73	25.00	26.85
July	24.20	25.70	18.56	25.00	25.00	26.82	24.32	25.12
August	29.04	25.00	20.37	23.37	27.74	26.50	26.17	25.00
September	35.02	24.96	25.40	22.81	33.76	26.50	30.08	24.92
October	31.63	23.76	27.04	20.11	33.23	25.33	30.23	24.00
November	28.78	21.84	24.12	19.04	31.70	23.82	28.28	21.20
December	25.92	21.96	22.70	20.36	27.78	23.00	24.96	20.96
Average	25.04	26.43	19.72	23.68	25.68	27.26	23.98	25.71

[a] Metal Statistics, 1924.

DAILY AVERAGE PRODUCTION

The daily average production of coke and anthracite pig iron, by months, during the last seven years is graphically illustrated in Figure 17. The curves of prices and production show little similarity until the later part of 1920, when the laws of demand and supply began to operate more normally than in the preceding four or five years.

PRODUCTION BY GRADES AND BY FUEL USED, TOTAL PRODUCTION, AND BLAST FURNACES

The statistics of production of pig iron by grades and by fuel used for 1919–1923, the total production of pig iron, and the number of furnaces in blast in 1922–1923 have been published by the American Iron and Steel Institute as given below. These figures include ferroalloys. Metals made with electricity and with coke and electricity are included in coke pig iron.

Pig iron manufactured in the United States, 1919–1923, by grades, in gross tons

Grade	1919	1920	1921	1922	1923
Bessemer and low-phosphorus	9,975,934	12,062,084	5,595,215	7,813,203	11,677,509
Basic	14,494,131	16,737,722	7,753,071	13,841,367	19,795,590
Forge	271,286	318,048	112,748	214,210	327,430
Foundry and ferrosilicon	4,916,758	5,957,782	2,568,136	3,976,431	6,470,013
Malleable	1,009,049	1,310,951	457,340	1,051,495	1,571,064
Spiegeleisen	84,246	111,449	56,423	73,443	129,686
Ferromanganese	185,357	295,447	103,755	150,115	247,031
White, mottled, direct castings, etc	78,603	132,504	41,438	99,640	142,823
	31,015,364	36,925,987	16,688,126	27,219,904	40,361,146

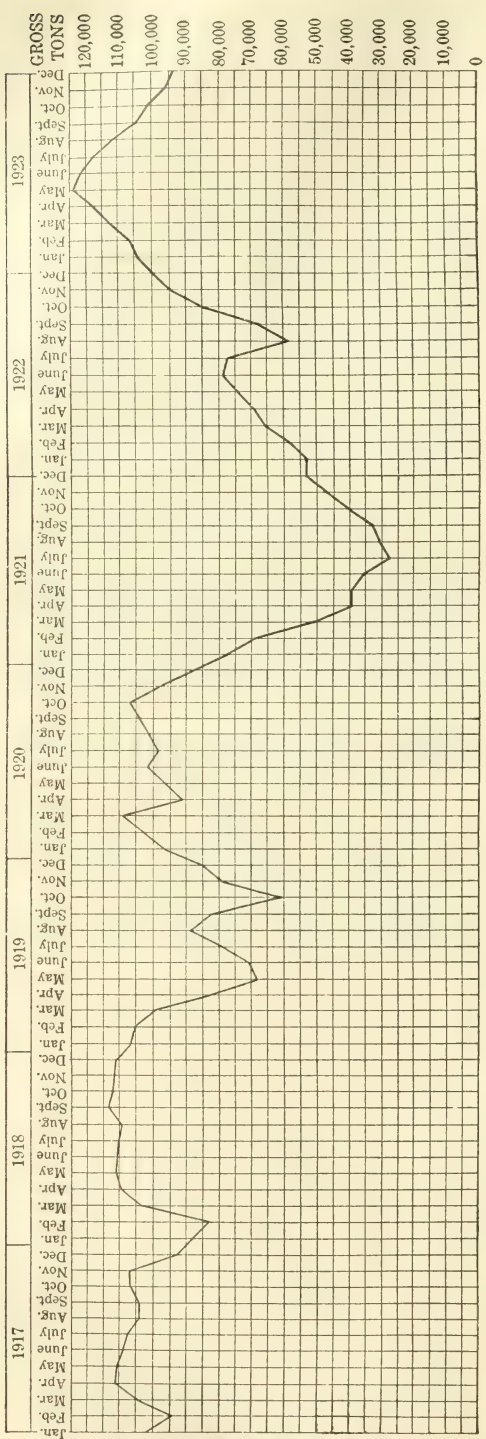

FIGURE 17.—Daily average production of coke and anthracite pig iron in the United States, 1917-1923, by months

Pig iron manufactured in the United States, 1919–1923, by fuel used, in gross tons

Fuel used	1919	1920	1921	1922	1923
Bituminous, chiefly coke	30, 549, 930	36, 300, 024	16, 579, 653	26, 995, 173	40, 097, 239
Anthracite and coke	138, 337	302, 567	13, 743		12, 730
Charcoal	327, 097	323, 396	94, 730	224, 731	251, 177
	31, 015, 364	36, 925, 987	16, 688, 126	27, 219, 904	40, 361, 146

The next table shows the production in the United States of pig iron, including the commoner ferroalloys, so far as has been recorded. Statistics by years prior to 1916 will be found in Mineral Resources for 1918 and earlier years.

Pig iron manufactured in the United States, 1810–1923

Year	Gross tons	Year	Gross tons	Year	Gross tons
1810–1860	10, 542, 548	1911–1915	137, 591, 093	1921	16, 688, 126
1861–1870	11, 366, 963	1916	39, 434, 797	1922	27, 219, 904
1871–1880	24, 055, 278	1917	38, 621, 216	1923	40, 361, 146
1881–1890	56, 902, 041	1918	39, 054, 644		
1891–1900	98, 124, 754	1919	31, 015, 364		819, 225, 795
1901–1910	211, 321, 934	1920	36, 925, 987		

The number of furnaces in blast on June 30 and December 31 and the total number of stacks recorded for 1922 and 1923, not including any electric reduction furnaces, are as follows:

Blast furnaces in the United States, 1922 and 1923

State	In blast June 30, 1922	Dec. 31, 1922			In blast June 30, 1923	Dec. 31, 1923		
		In	Out	Total		In	Out	Total
Pennsylvania	69	90	70	160	125	87	63	150
Ohio	41	58	22	80	67	48	29	77
Illinois	16	18	8	26	24	17	9	26
Alabama	22	25	18	43	30	23	20	43
New York	13	15	12	27	24	18	10	28
Virginia		4	13	17	6	3	14	17
Tennessee	2	6	11	17	7	2	15	17
Colorado	3	3	2	5	3	2	3	5
Missouri			3	3			3	3
Oregon			1	1				
Maryland	4	4	3	7	5	4	2	6
New Jersey	1	1	3	4	2	2	2	4
Wisconsin	3	4	3	7	5	1	6	7
Minnesota	2	3		3	3	3		3
Indiana	12	14	2	16	16	14	2	16
Michigan	9	13		13	12	11	2	13
West Virginia	2	3	2	5	4	3	1	4
Kentucky	2	1	6	7	2	1	6	7
Georgia			3	3			1	1
Texas			1	1			1	1
Mississippi			1	1			1	1
Connecticut			2	2			2	2
Massachusetts		1		1			1	1
	201	263	186	449	335	239	193	432

FOREIGN TRADE IN PIG IRON

The quantity of pig iron imported into the United States in 1923 decreased 4 per cent, compared with 1922.

Pig iron, including kentledge, ferromanganese, ferrosilicon, and spiegeleisen, 1919–1921, and pig iron, 1922–1923, imported into the United States, in gross tons [a]

Country	1919	1920	1921	1922	1923
North America:					
Canada	63,091	101,071	9,651	17,836	54,076
Cuba	30				
Mexico	5,994				1
Newfoundland and Labrador			13		
Panama				141	
South America: Brazil		466			
Europe:					
Austria					299
Belgium			12,004	64,449	14,980
France		5	127	41,704	57,722
Germany			3,508	4,085	20,740
Netherlands				2,537	
Sweden	51	105	1,088	408	705
Switzerland			10		
United Kingdom {England	32,452	64,008	9,302	152,833	179,937
United Kingdom {Scotland	39	10,208		98,950	18,201
Asia:					
China	8	3,555	4,610	502	3,129
Hongkong			250		
India (British)		1,977			17,988
Japan		3,851	2,002		
Kwangtung		200	1,213		
Oceania: Australia		498	258		
	101,665	185,944	44,036	383,445	367,778

[a] Separate figures for pig iron not available prior to 1922.

The pig iron exported from the United States in 1923 increased nearly 5 per cent in quantity and 14 per cent in value, as compared with 1922. Canada was the best customer in 1923, having taken 64 per cent of the total pig iron exported. The average price reported as received was $26.69 a ton in 1923, compared with $24.48 in 1922.

Pig iron exported from the United States to foreign countries, 1922–23, in gross tons

Country	1922	1923	Country	1922	1923
North America:			Europe—Continued.		
Canada	23,441	20,727	Germany	304	623
Cuba	216	660	Norway		10
Mexico	822	494	Sweden		25
Panama		46	United Kingdom—		
Other countries	82	196	England	2,316	7,442
South America:			Scotland	5	
Argentina	30	75	Asia:		
Brazil	125	10	China	996	170
Chile	310	450	Japan	135	80
Peru	497	298	Philippine Islands	544	9
Other countries	255	442	Other countries	200	
Europe:					
Belgium	472	551		30,920	32,318
France	170	10	Value	$756,842	$862,443

PRODUCTION BY COUNTRIES

In compiling the table of production of pig iron by countries since the war it has been necessary to use such statistics as are available and to revise figures from year to year as more complete and reliable data are obtained. For a time figures for the normal year 1913 were given for comparison, but changes in boundaries of countries in Europe have rendered comparisons with pre-war figures confusing.

The predominant position of the United States in pig-iron production is well shown, and the table in connection with that of exports from the United States indicates that the consumption in the principal European countries is still very moderate.

Pig iron (including ferroalloys) produced, 1920–1923, by countries, in metric tons

Country	1920	1921	1922	1923	Source of data [a]
Australia	349, 521	358, 020	84, 874	239, 328	1920–1923, 1.
Austria	99, 766	224, 031	320, 928	341, 875	1920–1922, 2; 1923, 3.
Belgium	1, 116, 400	872, 010	1, 497, 610	2, 147, 950	1920–1923, 5.
Brazil [b]	85			160	1920–1923, 4.
Canada	1, 014, 743	626, 199	366, 325	817, 158	1920, 7; 1921–1923, 8.
China	[b] 185, 389	150, 000	(c)	(c)	1920–1921, 9.
Chosen	38, 555	83, 273	83, 221	99, 933	1920–1923, 10.
Czechoslovakia	701, 137	917, 662	(c)	(c)	1920, 11; 1921, 12.
Finland	12, 961	7, 080	21, 553	37, 288	1920–1923, 13.
France	3, 344, 414	3, 446, 799	5, 276, 982	5, 431, 787	1920–21, 14; 1922, 15; 1923, 16.
Germany	6, 387, 625	6, 194, 000	6, 604, 000	(c)	1920, 17; 1921–22, 18.
Hungary	30, 000	51, 000	117, 000	(c)	1920–1922, 18.
India	348, 537	401, 548	374, 336	645, 333	1920–1923, 19.
Italy	108, 953	74, 762	175, 852	247, 043	1920–1922, 20; 1923, 21.
Japan	168, 870	96, 648	77, 265	89, 643	1920–1921,22; 1922–1923, 23.
Luxemburg	692, 935	970, 336	1, 679, 328	1, 406, 666	1920–1922, 25; 1923, 26.
New Zealand	(c)	(c)	82	(c)	1922, 27.
Norway	5, 771	2, 509	3, 759	(c)	1920–1922, 28.
Philippine Islands	87	174	156	269	1920, 29; 1921–1923, 29[a].
Poland	42, 221	60, 443	273, 516	547, 288	1920–1923, 30.
Rumania [d]	19, 007	33, 362	31, 419	39, 102	1920–1923, 32.
Russia [e]	103, 688	122, 853	166, 828	(c)	1920–1922, 31.
Spain	251, 412	347, 497	209, 792	400, 270	1920–1923, 33.
Sweden	[f] 488, 437	320, 037	275, 441	(c)	1920–1922, 34.
Union of South Africa	1, 368	1, 041			1920–1923, 35.
United Kingdom	8, 163, 674	2, 658, 292	4, 980, 982	7, 559, 920	1920,36;1921–1923, 37.
United States	37, 518, 649	16, 955, 970	27, 656, 783	41, 008, 942	1920–1923, 38.
Yugoslavia	15, 173	11, 881	15, 348	26, 361	1920–1923, 39.

[a] 1, Australian Metal Exchange; 2, Bundesmin. für Handel und Gewerbe, Industrie und Bauten; 3, data furnished by Bundesmin. f. Handel u. Verkehr.; 4, Commercio exterior do Brasil; 5, Statistique des industries extractives et métallurgiques; 7, Canada Dept. Mines, Mines Branch; 8, Dominion Bur. Statistics; 9, Director of the Geological Survey of China through U. S. consul general at Tientsin; 10, data furnished by U. S. consul general, Keijo; 11, State Statistical Office; 12, Montanistiche Rundschau; 13, data from Industristyrelsen through U. S. consul; 14, Statistique de l'industrie minérale en France et en Algérie; 15, data furnished by Direction des mines, Ministère des travaux publics, Paris; 16, Iron and Coal Trades Rev.; 17, Vierteljahrshefte zur Statistik des Deutschen Reichs; 18, Iron Trade Rev., Jan. 4, 1923; 19, India Geol. Survey Records; 20, Rivista del servizio minerario; 21, data furnished by Ministry of National Economy, Rome; 22, Financial and Economic Annual, Japan; 23, data furnished by Dept. Agr. and Com. Min. Bur., Tokyo; 25, official data through U. S. consul general, Rotterdam; 26, data furnished by U. S. consul, Antwerp; 27, official data furnished through U. S. consul, Auckland; 28, Bergverksdrift, Norges Offisielle Statistikk; 29, Mineral resources of the Philippines; 29[a], data furnished by Bur. Sci. Manila; 30, Polish Government through U. S. legation, Warsaw; 31, Commerce Repts., Jan. 12, 1923; 32, Statistique minière de la Roumanie; 33, Estadística minera de España; 34, Sveriges officiella Statistik, Bergshantering; 35, Dept. Mines and Industries Ann. Repts.; 36, Mines and Quarries, London; 37, Sec. Mines and H. M. Chief Insp. Mines Ann. Rept.; 38, American Iron and Steel Institute; 39, Ministry of Forests and Mines, through U. S. minister.

[b] Exports.

[c] Data not available.

[d] Year ending Mar. 31.

[e] Year ending Sept. 30.

[f] Includes sponge iron.

FERROALLOYS

SHIPMENTS, VALUE, AND PRICES

The statistics of output of ferroalloys in the United States are separated from those of pig iron in these reports in order to arrive at more nearly accurate values for these commodities. Although the quantity of ferroalloys is small compared with the total shipments of pig iron, the prices per ton are so much greater that they would unduly increase the apparent average price of the pig iron if included.

The shipments of ferroalloys of all classes in 1923, according to reports of all producers, increased 37 per cent in quantity and 77 per cent in value, as compared with 1922. The ferrovanadium, ferromolybdenum, ferromanganese, spiegeleisen, ferrotungsten, ferrochromium, and ferrotitanium were made in part or wholly from ore imported from Africa, Bolivia, Brazil, Chile, China, Cuba, India, Peru, Porto Rico, and Russia.

A review of the technical developments and market conditions of the ferroalloy industry by R. J. Anderson was published early in 1924.[8] According to Anderson, the general recovery in the metallurgical ferroalloy and ore industry that started in 1922 after the postwar slump in the steel trade has been continued through 1923, and some branches of the industry have been operated at about their physical limits. The markets for most ferroalloys and ores were much better in 1923 than in 1922, and there were substantial increases in imports, exports, and domestic shipments. A large amount of experimental work has been going on in the development of methods for the production of better grades of ferroalloys and in the development of special alloy steels. Rapid advance is being made in the use of special alloy steels, and ferroalloys have been the most potent factor in this advance, together with improved methods of manufacture and heat treatment.

The following publications on ores of the steel-hardening metals were issued by the United States Geological Survey during 1923:

Miser, H. D., Deposits of manganese ore in the Batesville district, Ark.: U. S. Geol. Survey Bull. 734, 273 pp., 1923.

Stose, G. W., and Schrader, F. C., Manganese deposits of east Tennessee: U. S. Geol. Survey Bull. 737, 154 pp., 1923.

Hess, F. L., Ilsemannite at Ouray, Utah: U. S. Geol. Survey Bull. 750–A, 16 pp., 1923.

In 1923 ferromanganese was reported made at 12 localities in the United States, spiegeleisen at 7, ferrosilicon at 13, ferrophosphorus at 3, ferrochromium at 5, ferromolybdenum at 3, ferrotitanium at 2, ferrotungsten at 7, ferrozirconium at 1, ferrovanadium at 5, and, zirconium-ferrosilicon at 1. In many localities, of course, several alloys were made at the same plant. There were 22 plants at which ferroalloys were made electrically or by a special process not involving a blast furnace.

The following records of average contract prices of ferromanganese and of spiegeleisen by months for the last four years show a wide range. The ferromanganese prices are quoted for material "delivered at Pittsburgh"; those of spiegeleisen are prices at producers' furnaces.

[8] Anderson, R. J., Ferroalloy developments in the past year: Iron Age, Jan. 3, 1924, pp. 94–97.

Ferroalloys of domestic manufacture shipped from furnaces in the United States, 1922 and 1923

Variety of alloy	1922		1923	
	Gross tons	Value	Gross tons	Value
Ferromanganese	[a] 161, 612	[a] $10, 673, 638	226, 365	$23, 853, 313
Spiegeleisen	70, 253	2, 162, 836	134, 086	4, 547, 113
Ferrosilicon (7 per cent or more silicon)	154, 866	7, 109, 928	184, 067	9, 940, 772
Ferromolybdenum	108	267, 168	118	297, 842
Ferrotungsten	610	641, 238	1, 485	2, 177, 685
Ferrovanadium	903	2, 516, 109	1, 432	3, 765, 344
Other varieties [b]	34, 928	4, 888, 087	32, 264	5, 295, 162
	423, 280	28, 259, 004	579, 817	49, 877, 231

[a] Includes a small quantity of silico-manganese.
[b] Ferrocarbide, ferrochromium, ferrophosphorus, ferrotitanium, ferrozirconium, and zirconium-ferrosilicon.

Quoted prices per ton of ferromanganese and spiegeleisen, 1920–1923 [a]

Month	Ferromanganese (delivered at Pittsburgh)				Spiegeleisen (at producer's furnace)			
	1920	1921	1922	1923	1920	1921	1922	1923
January	$146. 00	$101. 00	$61. 90	$109. 79	$46. 60	$46. 25	$25. 50	$34. 90
February	160. 00	96. 85	65. 32	112. 29	57. 60	37. 75	28. 00	35. 75
March	172. 00	89. 00	67. 82	120. 79	60. 40	34. 20	28. 00	37. 25
April	200. 00	87. 50	69. 07	124. 79	66. 85	32. 00	30. 00	39. 25
May	200. 00	83. 00	72. 32	129. 79	75. 00	31. 75	35. 00	43. 00
June	198. 00	76. 50	72. 82	129. 79	75. 00	29. 60	35. 25	46. 00
July	190. 00	75. 00	72. 29	122. 29	75. 00	27. 50	35. 00	45. 00
August	193. 75	70. 75	72. 29	122. 29	79. 35	26. 20	37. 00	45. 00
September	172. 40	64. 75	80. 59	114. 79	82. 00	25. 25	38. 00	43. 50
October	156. 40	61. 65	105. 47	112. 79	80. 00	24. 85	37. 75	40. 00
November	153. 00	60. 00	104. 92	113. 79	74. 35	25. 00	36. 80	39. 00
December	120. 00	60. 00	104. 92	113. 79	57. 90	25. 00	35. 50	39. 00

[a] Iron Trade Rev.

IMPORTS AND EXPORTS

The imports of the alloys of the rarer metals are not all reported separately. For instance, the imports of ferrochromium, ferromolybdenum, and ferrotungsten are included with those of their respective metals. Ferromanganese constituted the bulk of the imports, and most of it came from England.

Prior to the new tariff, which went into effect September 22, 1922, the Bureau of Foreign and Domestic Commerce recorded only the gross weight of the ferroalloy imported. Since that date only the manganese, silicon, etc., contained in such imports has been recorded. This change should be borne in mind in comparing the quantities in the two following tables. The values, however, are comparable.

The exports of ferroalloys are relatively unimportant, although in 1923, according to available statistics, they increased 141 per cent in quantity and 61 per cent in value. Ferromanganese constituted the greater part of the exports.

Ferroalloys imported for consumption in the United States, 1922–1923

Variety of alloy	1922 [a]			1923 [a]	
	Gross tons		Value	Gross tons	Value
	Jan. 1 to Sept. 21	Sept. 22 to Dec. 31			
Chrome or chromium and ferrochromium [b]	390	7	$118,870	1,481	$281,279
Ferrosilicon	12,740	2,032	830,808	11,544	1,044,221
Molybdenum and ferromolybdenum	13		36,246	[c]	5
Titanium and ferrotitanium	8	16	11,607	6	2,949
Tungsten and ferrotungsten	463	14	394,727	35	25,907
Ferrovanadium		[d]	3,770		
Ferromanganese	72,136	22,871	6,125,469	91,066	8,357,023
Spiegeleisen	3,899	4,252	268,135	4,668	165,791
			7,789,632		9,877,175

[a] Prior to Sept. 22, 1922, figures represent gross weight of the ferroalloy. Since that date the figures represent the weight of the chromium, silicon, etc., contained in the ferroalloy.
[b] Beginning with new tariff, Sept. 22, 1922, classification covers chromium metal, chromium-vanadium, and ferrochromium.
[c] 4 pounds.
[d] 1,160 pounds.

Ferromanganese and ferrosilicon imported into the United States, 1922–1923, by countries

[General imports]

Country	Alloy	1922 [a]			1923 [a]	
		Gross tons		Value	Gross tons	Value
		Jan. 1 to Sept. 21	Sept. 22 to Dec. 31			
Belgium	Ferrosilicon	31		$1,246	86	$12,136
Canada	Ferromanganese	90		6,166	52	1,503
	Ferrosilicon	11,245	1,718	755,326	9,557	841,144
England	Ferromanganese	70,482	22,556	5,988,932	88,229	8,564,813
	Ferrosilicon	850		49,953	41	1,731
France	Ferromanganese	34	6	8,393	86	13,925
	Ferrosilicon				77	8,537
Germany	Ferromanganese	875	80	57,027	199	24,025
	Ferrosilicon				91	10,959
Netherlands	Ferromanganese	500		30,615		
Norway	do	25		1,483		
	Ferrosilicon	649		24,380	1,115	106,398
Sweden	Ferromanganese	5		1,800	4	1,042
	Ferrosilicon				768	73,420
Switzerland	Ferromanganese		5	562		

[a] Prior to Sept. 22, 1922, figures represent gross weight of the ferroalloy. Since that date the figures represent the weight of the manganese or silicon content of the ferroalloy.

Ferroalloys exported from the United States, 1921–1923

Variety of alloy	1921		1922		1923	
	Gross tons	Value	Gross tons	Value	Gross tons	Value
Ferromanganese	690	$100,474	1,107	$76,822	[a] 4,295	[a] $151,224
Spiegeleisen	[a]	[a]	289	7,740		
Ferrochrome and chrome metal	[a]	[a]	23	1,941	[a]	[a]
Ferrosilicon	368	20,204	689	30,939	814	31,154
Tungsten and ferrotungsten			[b]	43,219	[c] 2	[c] 122,906
Ferrovanadium	98	424,886	22	69,279	23	64,713

[a] Not separately classified. [b] 1,009 pounds [c] Includes tungsten wire.

STEEL

PRODUCTION

The following tables showing the production of steel were compiled by the American Iron and Steel Institute. No data whatever are available on the value of the output of crude steel at the mills, but the weekly issues and annual statistical reviews of the Iron Age give market quotations of prices of steel billets and some of the leading forms of finished steel. The price of Bessemer steel billets at Pittsburgh in 1923 ranged from $37.30 to $45 a gross ton; in 1922 it ranged from $28 to $40. Tank plates at Pittsburgh ranged from 2.06 to 2.50 cents a pound in 1923 and from 1.39 to 2.13 cents in 1922. Steel beams at Pittsburgh ranged from 2.06 to 2.50 cents a pound in 1923 and from 1.39 to 2 cents in 1922.

Bessemer steel ingots and castings manufactured in the United States, 1919–1923, in gross tons

State	1919	1920	1921	1922	1923
Ohio	3,073,941	3,662,718	1,581,610	2,324,425	3,557,579
Pennsylvania	2,851,402	3,279,023	1,665,456	2,474,956	3,115,840
Illinois	906,324	1,243,837	532,539	707,067	1,057,576
Other States	439,895	697,509	236,333	412,850	753,093
	7,271,562	8,883,087	4,015,938	5,919,298	8,484,088

Open-hearth steel ingots and castings manufactured in the United States, 1919–1923, in gross tons

State	1919	1920	1921	1922	1923
New England States	286,826	290,967	102,642	204,343	268,630
New York and New Jersey	1,296,005	2,010,895	634,290	1,597,881	1,951,278
Pennsylvania	12,692,112	14,184,477	6,408,043	11,583,812	14,428,187
Ohio	5,112,616	6,341,016	3,108,332	6,770,293	7,786,820
Indiana	3,122,486	3,785,056	2,308,414	3,571,397	4,326,724
Illinois	1,664,993	2,302,776	1,093,268	2,077,920	2,579,095
Other States	2,773,656	3,756,708	1,934,813	3,503,337	4,558,923
	26,948,694	32,671,895	15,589,802	29,308,983	35,899,657

According to these tables there were increases of 43 per cent in the production of Bessemer steel and of 22 per cent in open-hearth steel in 1923 compared with 1922. In the total production of steel there was an increase of 26 per cent. Of the total output in 1923, nearly 80 per cent was represented by open-hearth steel, nearly 19 per cent by Bessemer steel, and a little more than 1 per cent by all other classes of steel.

Of the total output of open-hearth steel, 34,665,021 gross tons was made by the basic process and 1,234,636 tons by the acid process, compared with 28,387,171 tons of basic steel and 921,812 tons of acid steel in 1922.

The production of steel by the electric process in 1923 showed an increase of 49 per cent as compared with 1922.

Steel electrically manufactured in the United States, 1909 to 1923, in gross tons

Year	Ingots	Castings	Total	Year	Ingots	Castings	Total
1909	13,456	306	13,762	1917	239,632	64,911	304,543
1910	50,821	1,320	52,141	1918	403,068	108,296	511,364
1911	27,227	1,878	29,105	1919	272,942	111,510	384,452
1912	14,147	4,162	18,309	1920	346,956	155,196	502,152
1913	20,973	9,207	30,180	1921	84,404	85,095	169,499
1914	15,458	8,551	24,009	1922	191,057	154,982	346,039
1915	46,348	23,064	69,412	1923	279,914	235,958	515,872
1916	126,048	42,870	168,918				

In the total production of electric steel in 1923 are included 194,976 tons of alloy-steel ingots and castings which were alloyed with nickel, vanadium, tungsten, chromium, molybdenum, and other metals (165,922 tons of ingots and 29,054 tons of castings), compared with 125,419 tons (107,659 tons of ingots and 17,760 tons of castings) so alloyed in 1922.

On December 31, 1923, the number of completed plants equipped for the manufacture of steel by the electric process was 203, the same number as at the end of 1922.

Steel produced in the United States, 1810–1923, in gross tons

Year	Bessemer	Open-hearth	Crucible	Other steel	Total
1810–1870	58,482	2,232	146,370		207,084
1871	40,179	1,785	31,250		73,214
1872–1880	4,293,896	245,035	349,730	76,009	4,964,670
1881–1890	21,596,699	2,387,925	703,489	37,044	24,725,157
1891–1900	49,387,341	15,392,764	762,446	35,820	65,578,371
1901–1910	94,048,698	92,418,814	1,051,379	154,683	187,673,574
1911–1915	42,329,520	98,833,090	544,047	185,692	141,892,349
1916	11,059,039	31,415,427	129,692	169,522	42,773,680
1917	10,479,960	34,148,893	126,716	305,038	45,060,607
1918	9,376,236	34,459,391	115,112	511,693	44,462,432
1919	7,271,562	26,948,694	63,572	387,404	34,671,232
1920	8,883,087	32,671,895	72,265	505,687	42,132,934
1921	4,015,938	15,589,802	7,613	170,444	19,783,797
1922	5,919,298	29,308,983	28,606	346,039	35,602,926
1923	8,484,088	35,899,657	44,079	515,872	44,943,696

FOREIGN TRADE IN STEEL

According to available records the value of the steel and iron imported in 1923 showed a decrease of 4 per cent as compared with that of 1922; the exports of steel and iron decreased 3 per cent in quantity but increased 24 per cent in total value.

Iron and steel imported into the United States, 1921–1923

Article	1921		1922		1923	
	Gross tons	Value	Gross tons	Value	Gross tons	Value
Bar iron	1,913	$203,486	8,092	$516,380	7,754	$451,508
Boiler and other plate of iron and steel	[a]	[a]	[b] 1,141	[b] 42,003	1,818	91,478
Iron and steel scrap	41,469	479,800	142,969	1,841,375	162,068	2,783,406
Rails for railways	22,048	847,122	26,629	886,569	29,706	963,142
Sheets of iron or steel, skelps, saw plates and steel	[a]	[a]	[b] 380	[b] 52,470	2,754	316,538
Sheets and plates	1,976	301,423	[c] 426	[c] 94,048	[d]	[d]
Steel ingots, bars, etc	10,024	1,290,404	27,720	2,597,382	22,671	2,371,886
Tin and terne plates	455	122,880	2,682	309,255	10,037	1,166,790
Wire and articles made from wire		1,259,811		1,467,556		3,562,923
Wire rods	917	115,942	1,735	150,980	3,948	312,899
All other manufactures—free		231,526		[c] 364,773		
All other manufactures—dutiable		6,201,847		7,135,199		2,813,579
		11,054,241		15,457,990		14,834,149

[a] Not separately classified prior to Sept. 22, 1922.
[b] September 22 to December 31.
[c] January 1 to September 21.
[d] Classification discontinued with new tariff, Sept. 22, 1922.

Iron and steel exported from the United States, 1921–1923

Article	1921		1922		1923	
	Gross tons	Value	Gross tons	Value	Gross tons	Value
Axes		$1,325,374		$692,136		$1,174,897
Bars or rods (of steel):						
Wire	18,953	1,112,234	40,424	1,819,504	40,868	2,163,436
All other	188,463	14,043,840	13,897	1,487,031	115,845	11,512,552
Billets, ingots, blooms, sheet, bar, and skelp	10,071	516,498	107,334	3,986,004	111,233	5,868,048
Bolts and nuts	24,230	4,884,596	18,325	3,035,426	18,907	3,823,324
Hammers and hatchets		651,341		247,971		396,925
Hoops and bands	22,274	2,013,798	34,512	2,742,947	38,244	4,401,997
Horseshoes	615	109,444	987	164,461	951	149,251
Horseshoe nails	[a]	[a]	795	241,279	1,113	305,553
Iron and steel bars, not containing alloys	[b] 12,338	[b] 1,190,669	171,356	8,960,726	[b] 12,662	[b] 1,075,518
Iron and steel scrap	37,592	580,023	64,784	996,507	65,980	1,035,637
Nails:						
Cut nails	1,094	133,629	3,509	283,360	2,300	202,906
Wire nails	28,109	3,192,054	55,022	4,127,136	45,981	4,103,330
All other, including tacks	4,691	1,178,064	4,053	1,064,137	5,346	1,436,978
Radiators and cast-iron house-heating boilers	3,408	575,427	5,413	911,499	5,963	1,090,128
Rails for railways, of steel	321,822	18,395,580	277,090	10,833,210	267,409	10,273,970
Railroad spikes	8,164	908,755	7,895	530,754	8,597	686,331
Railroad-track material, switches, frogs, fishplates, splices, bars, etc	[c]	6,461,731	30,402	2,868,524	30,991	3,097,253
Saws		2,358,243		606,171		2,003,535
Sheets and plates:						
Galvanized	56,085	7,754,843	109,320	10,191,841	114,749	12,395,505
Iron	12,414	1,578,055	15,389	689,062	16,016	1,089,565
Shovels and spades		561,432		393,133		533,517
Steel:						
Plates, not fabricated	335,868	23,285,080	88,617	3,906,073	102,375	6,672,012
Sheets, black	193,433	18,732,662	214,911	15,899,934	139,105	13,514,749
Structural iron and steel	297,022	26,824,258	167,585	9,672,927	198,991	13,584,040
Tin and terne plates	107,714	17,415,152	76,633	7,950,473	124,499	14,791,961
Tubular products and fittings:						
Boiler tubes	[a]	[a]	12,073	1,552,354	16,518	2,397,182
Wrought pipes and fittings	345,376	48,953,189	[d]	[d]	[d]	[d]
Casings and oil-line pipes	[a]	[a]	51,726	4,517,507	64,118	7,041,769
Welded black pipes	[a]	[a]	75,073	6,040,936	76,591	7,398,704
Welded galvanized pipes	[a]	[a]	32,519	3,228,290	28,681	3,351,836
Malleable-iron pipe fittings	[a]	[a]	7,848	1,839,274	7,747	2,400,367
Cast pipe and fittings	48,645	7,265,747	[d]	[d]	[d]	[d]
Cast-iron pipe	[a]	[a]	18,001	1,340,693	15,308	1,538,500
Cast-iron pipe fittings	[a]	[a]	9,301	2,010,651	12,757	3,193,877
Wire:						
Barbed	29,976	3,558,691	70,828	5,475,578	70,803	6,173,678
All other	69,336	8,726,123	138,839	13,033,702	103,985	14,437,465
All other tools		8,354,163		9,773,831		11,600,979
		232,640,695		143,115,042		176,917,275

[a] Not separately classified prior to Jan. 1, 1922.
[b] Iron bars only.
[c] Weight not recorded prior to 1922.
[d] Various classes shown separately beginning Jan. 1, 1922.

GOLD, SILVER, COPPER, AND LEAD IN CALIFORNIA

(MINE REPORT)

By JAMES M. HILL [1]

PRODUCTION

The gold, silver, copper, and lead produced in California in 1923 showed a decrease of less than 1 per cent in total value as compared with 1922, notwithstanding the decrease of 18 cents in the average price of silver and the fact that no zinc was produced in the State in 1923. The decline of $2,314,061 in the production of gold from deep mines was partly offset by the increase in output of placers (almost entirely the dredges) amounting to $1,022,728, and the net loss in gold output for the year was $1,291,333, or 9 per cent, as compared with 1922. The quantity of silver increased 15 per cent, but the value decreased 6 per cent. Copper increased nearly 26 per cent and lead 51 per cent in quantity.

Mine production of gold, silver, copper, lead, and zinc in California, 1919–1923

Year	Number of producing mines	Ore (short tons)	Gold [a]	Silver [a] (fine ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)	Total value
1919	650	1,714,911	$16,695,955	1,107,189	21,732,507	3,568,267	472,990	$22,201,898
1920	500	1,165,022	14,311,043	1,706,327	12,626,272	4,813,510	1,165,509	18,973,660
1921	573	1,215,600	15,704,822	3,629,223	11,743,404	1,124,276	1,057,731	20,952,423
1922	565	1,539,933	14,670,346	3,100,065	22,539,485	6,312,536	3,012,950	21,332,168
1923	621	1,535,691	13,379,013	3,559,443	28,317,759	9,549,680	----------	21,128,945

[a] Includes placer production.

Gold and silver produced at placer mines in California, 1919–1923

Year	Dredges		Drift		Hydraulic		Surface		Total value
	Gold	Silver	Gold	Silver	Gold	Silver	Gold	Silver	
		Fine ounces		*Fine ounces*		*Fine ounces*		*Fine ounces*	
1919	$7,716,919	25,741	$85,341	558	$184,832	1,270	$45,984	355	$8,064,351
1920	6,900,366	28,918	62,925	374	66,233	413	31,089	195	7,093,204
1921	7,756,787	36,322	127,411	615	162,808	864	107,818	829	8,193,454
1922	4,999,215	16,608	252,626	1,391	158,275	906	89,739	708	5,519,468
1923	6,065,735	17,569	184,771	955	111,828	626	160,249	1,155	6,539,233

[1] Miss Helen M. Gaylord, of the U. S. Geological Survey, assisted in the preparation of this report.

ORE

The quantity of ore mined in California in 1923 decreased slightly as compared with 1922. Gold ore decreased about one-fifth, silver ore doubled, copper ore increased about one-fourth, copper-lead ore increased 77 per cent, and lead ore increased 45 per cent. The average value of all ore and tailings treated was $9.50 a ton, of which $6.35 was in gold and silver, as compared with $10.27 and $7.96, respectively, in 1922. The copper-lead ore (a very small quantity) held the highest average value, and the copper ore the lowest.

Ore and metals produced in California in 1923

Source	Ore and tailings		Gold		Silver	
	Short tons	Per cent	Fine ounces	Per cent	Fine ounces	Per cent
Dry gold ore and tailings	789,026	51.38	311,477.79	48.12	82,787	2.33
Dry silver ore and tailings	136,633	8.90	9,979.00	1.54	2,762,977	77.62
Copper ore and tailings	571,645	37.22	8,523.74	1.33	360,345	10.12
Copper-lead ore	83	.01	44.87	.01	2,788	.08
Lead ore	38,304	2.49	1,654.38	.25	330,241	9.28
Total, deep mines	1,535,691	100.00	331,679.78	51.25	3,539,138	99.43
Total, placers			315,529.97	48.75	20,305	.57
	1,535,691	100.00	647,209.75	100.00	3,559,443	100.00
Increase or decrease from 1922	−4,242		−62,468.24		+459,378	

Source	Copper		Lead	
	Pounds	Per cent	Pounds	Per cent
Dry gold ore	192		288	
Dry silver ore	4,950	0.02	4,130	0.04
Copper ore and tailings	28,238,052	99.72		
Copper-lead ore	7,684	.03	35,090	.37
Lead ore	66,881	.23	9,510,172	99.59
	28,317,759	100.00	9,549,680	100.00
Increase from 1922	5,778,274		3,237,144	

Value of recoverable metals in ore and tailings treated in California in 1923

Kind of ore	Ore and tailings (short tons)	Total value		Average value per ton	
		In gold and silver	In all metals	In gold and silver	In all metals
Dry gold ore and tailings	789,026	$6,506,628	$6,506,676	$8.25	$8.25
Dry silver ore and tailings	136,633	2,471,924	2,472,941	18.09	18.10
Copper ore and tailings	571,645	471,760	[a] 4,622,755	.83	8.09
Copper-lead ore	83	3,214	6,800	38.72	81.93
Lead ore	38,304	304,997	980,540	7.96	25.60
	1,535,691	9,758,523	14,589,712	6.35	9.50

[a] Includes value of some copper from mine waters.

Content of ore and tailings sold or treated in California in 1923

Dry gold ores

County	Ore and tailings	Gold	Silver	Copper	Lead
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Amador	212,188	82,523.84	18,260		
Butte	231	135.98	19		
Calaveras	173,630	48,908.18	6,778		
Eldorado	388	675.49	120		
Fresno	78	48.47	10		
Inyo	150	132.06	98	161	
Kern	5,225	4,009.01	1,719		
Lassen	45	9.35	57		
Los Angeles	59	34.54	7		
Madera	1,170	565.94	653		
Mariposa	12,612	6,733.31	2,034		
Mono and Modoc	3,661	1,690.37	3,813		
Nevada	256,256	108,935.54	37,092		
Placer	116	162.17	24		
Plumas	1,077	350.97	53		
Riverside	1	2.34	1		
San Bernardino	2,947	1,198.76	814	31	
San Diego	25	19.48	173		
Shasta	787	633.93	130		
Sierra	50,847	41,288.45	7,368		
Siskiyou	660	759.67	135		288
Trinity	243	323.77	45		
Tuolumne	66,630	12,336.17	3,384		
	789,026	311,477.79	82,787	192	288
Decrease from 1922	195,759	119,331.66	14,341	3,104	1,693

Dry silver ores

Butte	5	0.47	170		
Imperial	500	1.10	7,335		
Inyo	135	13.03	3,220		
Kern	15,487	1,053.04	38,671		
San Bernardino	120,506	8,911.36	2,713,581	4,950	4,130
	136,633	9,979.00	2,762,977	4,950	4,130
Increase or decrease from 1922	+69,270	+4,886.06	+387,616	−2,564	+3,915

Copper ores

Calaveras	36,104		1,463	1,598,726	
Del Norte	12			5,250	
Inyo	15		83	6,284	
Plumas	476,128	7,072.26	297,368	22,866,339	
San Bernardino	18		19	6,555	
Shasta	54,768	1,081.49	56,315	3,478,598	
Trinity	4,600	369.99	5,097	276,300	
	571,645	8,523.74	360,345	28,238,052	
Increase or decrease from 1922	+124,445	+2,794.89	+39,368	+6,392,941	−214

Copper-lead ores

Inyo	25	13.87	1,830	1,888	7,993
Riverside	58	31.00	958	5,796	27,097
	83	44.87	2,788	7,684	35,090
Increase or decrease from 1922	+36	+34.92	−5,127	+3,546	+30,796

Lead ores

Inyo	37,832	1,616.46	317,967	65,185	9,479,591
Orange	413	20.05	12,116	757	27,754
San Bernardino	59	17.87	158	939	2,827
	38,304	1,654.38	330,241	66,881	9,510,172
Increase from 1922	11,838	202.57	66,560	937	3,204,340

GOLD

It is difficult to credit the gold reported as produced in California to the several counties and to placers and deep mines, for much of the gold reaches the mint with no means of identifying its origin. A large part of this gold is won by small mine owners who do not respond to the Geological Survey's inquiries, and a considerable part is without doubt the result of operations by "high-graders." For 1923 it is estimated that at least $120,000 worth of gold belongs in this class. Bankers and storekeepers at such centers as Sonora, Angels Camp, Jackson, Nevada City, Grass Valley, Oroville, Redding, and Yreka purchase or ship gold that comes from a considerable territory tributary to those towns, and often no record is kept of the persons for whom the bullion is handled or of its origin. These lots are usually small, but in the course of a year they aggregate a considerable number of ounces, which must be apportioned according to the Survey's best judgment.

In 1923 there were 35 companies that produced over 1,000 ounces of gold each, which contributed 90 per cent of the total gold output of California. Of these, 13 operated dredges, 17 deep gold quartz mines, 2 copper mines, 2 silver mines, and 1 lead mine. The ten largest gold-producing companies, in order of output, were the Yuba Consolidated Gold Fields (6 dredges), Natomas Co. of California (8 dredges), Empire Mines Co. (gold quartz), Carson Hill Gold Mines (Inc.) (gold quartz), North Star Mines Co. (gold quartz), Sixteen to One (gold quartz), Kennedy Mining & Milling Co. (gold quartz), Marysville Dredging Co. (1 dredge), Central Eureka Mining Co. (gold quartz), Argonaut Mining Co. (gold quartz). The gold produced in each of five counties in 1923 was valued at more than $1,000,000—Yuba County (dredges), $3,150,405; Nevada (quartz), $2,282,155; Amador (quartz), $1,734,133; Sacramento (dredges), $1,331,227; and Calaveras (quartz), $1,205,784.

In 1923 deep mines produced 51 per cent and placer mines 49 per cent of the total gold output of California. In 1922 the relative proportions were 62.5 and 37.5 per cent, respectively; in 1921, 48 and 52 per cent; and in 1920, 51 and 49 per cent. Most of the 353 placer mines operated in California in 1923 were relatively small. Aside from the 29 dredges only 7 placers, of which 2 were hydraulic, 4 drift, and 1 surface mine, produced more than $10,000 in gold each.

The yield of placer gold was valued at $6,522,583, an increase of 19 per cent, as compared with the yield in 1922. The 29 dredges produced 93 per cent, the 64 drift mines 2.8 per cent, the 92 hydraulic mines 1.7 per cent, and the 168 surface mines 2.5 per cent of the total. Dredges produced $1,066,520 more than in 1922, and the greater part of the increase was in the Yuba River and Trinity River fields. The dredges in Butte, Calaveras, Sacramento, and Shasta counties produced less gold than in 1922. The drift mines yielded $67,855 less than in 1922. Butte County mines were the largest producers in this class. There was a net decrease of $46,447 in the gold yield of hydraulic mines, of which Trinity, Siskiyou, and Sierra counties still contain the largest producers. The production from surface placers increased $70,510 and included some gold from almost every mining county, but the individual production by this form of mining is relatively small.

The production of gold from deep mines was valued at $6,856,430, a decrease of 25 per cent as compared with 1922. Of the 268 deep mines that reported production, only 23 yielded more than $20,000 worth of gold each, only 5 more than $400,000, and only 2 more than $1,000,000. Deep mines in Nevada County produced the greatest quantity of gold ($2,251,897), followed by Amador County ($1,705,919), Calaveras County ($1,011,022), Sierra County ($853,508), and Tuolumne County ($255,011). There were large decreases in the gold yield from deep mines in Amador, Calaveras, Nevada, and Sierra counties and smaller decreases in Inyo, Kern, Mariposa, Mono, Placer, Shasta, and Siskiyou counties, but increases in Plumas, San Bernardino, and Tuolumne counties.

The dry gold ores mined and old tailings treated, amounting to 789,026 tons (195,759 tons less than in 1922), yielded 94 per cent of the gold produced at deep mines and 48 per cent of the total gold produced in the State. Dry silver ores and tailings (136.633 tons) gave about 3 per cent, and copper ores and tailings (571,645 tons) 2.6 per cent of the gold from deep mines.

SILVER

Of the total silver output of California in 1923 the 45 properties that produced over 1,000 ounces each contributed 99 per cent. At 22 properties between 1,000 and 5,000 ounces was produced, at 11 between 5,000 and 10,000 ounces, at 7 between 10,000 and 50,000 ounces, at 4 between 100,000 and 200,000 ounces, and at 1 (California Rand Silver, Inc.) more than 2,500,000 ounces. Of the mines with an output of over 100,000 ounces 2 were lead mines in Inyo County and 2 were copper mines in Plumas County. San Bernardino County held first rank in silver production, followed by Inyo, Plumas, and Shasta counties. The 10 largest silver producers in the State, named in order of rank, were the California Rand Silver (Inc.) (silver ore), Engels Copper Co. (copper ore), Walker Mining Co. (copper ore), Darwin Silver Co. (lead ore), Tecopa Consolidated Mining Co. (lead ore), Zenda Mining Co. (silver ore), Mammoth Copper Co. (copper ore), Cerro Gordo Mines Co. (lead ore), Empire Mines Co. (gold ore), and Mountain Copper Co. (copper ore).

The increase in the quantity of silver produced was due in great part to larger shipments from the Rand silver mines, in San Bernardino County, and to the lead ores produced in Inyo County, though the Zenda mine, in the Amelia district, Kern County, which produces silver ore, made a considerable increase. Increases in the production of silver were also made in Nevada, Orange, Shasta, and Trinity counties.

The output of silver from placer mines was 20,305 ounces, valued at $16,650, a small increase in quantity. The production of silver from deep mines was 3,539,138 ounces, valued at $2,902,093, an increase of 15 per cent in quantity but a decrease of 6 per cent in value, as compared with 1922. The Kelly mine, of the California Rand Silver (Inc.), at Randsburg, was by far the largest producer of silver in the State. Lead ores from Inyo County gave the second largest output of silver, and copper ore from Plumas County the third. Dry gold ores gave 2.3 per cent, silver ores 77.6 per cent, cop-

per ores 10.1 per cent, and lead ores 9.3 per cent of the total silver yield. Concentrates carried 72 per cent, and ore sent direct to smelters 24 per cent of the total silver produced at deep mines, the remainder of the silver from ore being recovered at gold smelting plants.

COPPER

The output of copper at California mines in 1923 was 28,317,759 pounds, valued at $4,162,711, an increase of 26 per cent in quantity and 37 per cent in value, as compared with 1922. The increase was due largely to greater activity at the Engels and Walker mines, in Plumas County, though considerable copper was recovered from ores in Shasta, Calaveras, and Trinity counties.

Copper ores yielded approximately 94 per cent of the copper produced, and tailings and leaching more than 5 per cent. Of the total output, 80 per cent was recovered by smelting concentrates and 20 per cent by smelting crude ore and leaching tailings and from mine waters. Copper ore was smelted at two plants in Shasta County and one in Calaveras County, but the bulk of the copper ore produced was concentrated by flotation and the concentrates shipped to Utah smelters.

LEAD

The production of lead at California mines in 1923 was 9,549,680 pounds, valued at $668,478, an increase of 51 per cent in quantity and 93 per cent in value, as compared with 1922. This increase was due to the greater activity in lead mining in Inyo County, where there was a gain in yield of 51 per cent. The principal producers were the Tecopa, Darwin, and Cerro Gordo mines. A small quantity of lead was contained in ore mined in Orange, Riverside, and San Bernardino counties.

Practically all the lead produced (99.6 per cent) was recovered from lead ores. Crude ore smelted yielded 81 per cent and concentrates 19 per cent of the total output. All the lead ore and concentrates produced were smelted at Utah plants.

ZINC

No zinc was produced from ores mined in California in 1923. Zinc contained in copper ores mined in Shasta County was not saved, and so far as could be ascertained no zinc ore was shipped from any of the mines in the southern part of the State. The production in 1922 was 3,012,950 pounds (recovered as zinc oxide), valued at $171,738.

METALLURGIC INDUSTRY

Of the gold produced from ore and tailings 71 per cent was recovered by amalgamation and 19 per cent by cyanidation; of the silver, 1.6 per cent by amalgamation and 2.2 per cent by cyanidation.

The concentrates produced showed an increase of 15 per cent, the yield of gold from concentrates a decrease of 19 per cent, of silver an increase of 137 per cent, of copper an increase of 13 per cent, and of lead an increase of 73 per cent. Concentrates treated by cyanida-

tion yielded 6.7 per cent of the gold recovered from ore and tailings and 0.2 per cent of the silver, and concentrates smelted yielded 9 per cent of the gold, 72 per cent of the silver, 80 per cent of the copper, and 19 per cent of the lead.

From incomplete statistics it is judged that amalgamation mills in California used from 0.01 to 0.05 pound of quicksilver to a ton of ore treated and 0.03 to 0.06 pound to an ounce of gold recovered.

Metallurgic recovery of metals in California in 1923

Process	Material treated	Gold	Silver	Copper	Lead
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Ore amalgamated	724,107	234,939.25	57,538		
Ore cyanided	16,212	39,860.89	61,551		
Concentrates cyanided	9,039	22,216.81	5,709		
Tailings cyanided	3,500	404.91	10,722		
Ore smelted	51,349	4,608.47	836,725	4,235,593	7,729,693
Concentrates smelted	58,563	29,340.96	2,547,855	22,569,863	1,819,987
Tailings treated	25,241	308.49	19,038	[a] 1,512,303	
		331,679.78	3,539,138	28,317,759	9,549,680

[a] Includes copper from mine water and from leaching of pyrite cinder.

Gold and silver produced at mills in California in 1923 [a]

County	Ore to gold and silver mills	Gold in bullion	Silver in bullion	Ore to concentrating mills
	Short tons	*Fine ounces*	*Fine ounces*	*Short tons*
Amador	212,184	69,745.63	14,854	
Butte	236	136.45	189	
Calaveras	173,630	36,108.88	4,379	35,685
Eldorado	388	675.49	120	
Fresno	73	42.74	6	
Inyo	285	145.09	3,318	22,167
Kern	20,612	5,024.28	40,315	100
Lassen	45	9.35	57	
Los Angeles	59	34.54	7	
Madera	1,170	386.48	323	
Mariposa	12,612	6,347.68	1,703	
Mono	2,159	1,464.35	3,034	
Nevada	256,256	107,958.88	35,487	
Orange				400
Placer	116	162.17	24	
Plumas	1,074	335.06	49	468,461
Riverside	1	2.34	1	
San Bernardino	3,611	1,132.74	7,210	114,223
San Diego	5	5.54	2	20
Shasta	787	586.82	115	11,971
Sierra	50,804	40,727.85	7,281	
Siskiyou	660	647.25	103	
Trinity	243	323.77	45	
Tuolumne	3,309	2,796.76	467	62,255
	740,319	274,800.14	119,089	715,282
Increase or decrease from 1922	−195,813	−97,680.13	+26,336	+169,150
Average content per ton		0.3712	0.1609	

[a] Tailings excluded.

Metals produced from California concentrates in 1923

By counties

	Concentrates	Gold	Silver	Copper	Lead
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Amador	2,682	12,726.16	3,387		
Calaveras	10,904	12,799.30	3,862	946,782	
Inyo	2,171	164.99	110,036	18,403	1,794,871
Kern	17	37.77	75		
Madera	20	179.46	330		
Mariposa	76	385.63	331		
Nevada	388	976.66	1,605		
Orange	82	18.85	11,045	757	24,828
Plumas	39,285	6,760.06	294,056	21,042,742	
San Bernardino	6,383	7,688.00	2,125,534		
San Diego	4	13.94	171		
Shasta	1,579	54.11	211	561,179	
Sierra	60	414.24	68		
Siskiyou	28	112.42	32		288
Tuolumne	3,923	9,226.18	2,821		
	67,602	51,557.77	2,553,564	22,569,863	1,819,987
Increase or decrease from 1922	+9,008	−11,705.90	+1,475,545	+2,656,064	+767,776

By kinds of concentrates

Dry gold	12,300	36,918.87	11,232		288
Dry silver	6,383	7,688.00	2,125,534		
Copper	46,666	6,767.06	295,717	22,550,703	
Lead	2,253	183.84	121,081	19,160	1,819,699
	67,602	51,557.77	2,553,564	22,569,863	1,819,987

Average content

	Fine ounces per ton	*Fine ounces per ton*	*Per cent*	*Per cent*
Dry gold	3.00	0.91		
Dry silver	1.20	333.00		
Copper	.15	6.34	24.16	
Lead	.08	53.74	.43	40.38
Average	.76	37.77	16.69	1.35

Mine production of metals from California crude ore shipped to smelters in 1923 [a]

By counties

	Crude ore	Gold	Silver	Copper	Lead
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Amador	4	52.05	19		
Calaveras	272			489,544	
Del Norte	12			5,250	
Fresno	5	5.73	4		
Inyo	15,705	1,465.34	209,844	55,115	7,692,713
Mono	2	104.44	78		
Orange	13	1.20	1,071		2,926
Plumas	7,670	328.11	3,316	1,823,597	
Riverside	58	31.00	958	5,796	27,097
San Bernardino	5,246	1,307.25	579,172	12,475	6,957
Shasta	17,703	766.00	37,081	1,567,516	
Sierra	43	146.36	19		
Trinity	4,600	369.99	5,097	276,300	
Tuolumne	16	31.00	66		
	51,349	4,608.47	836,725	4,235,593	7,729,693
Increase or decrease from 1922	−6,320	−3,270.07	−1,072,955	+1,609,907	+2,469,368

[a] Tailings excluded.

Mine production of metals from California crude ore shipped to smelters in 1923—Continued

By kinds of ore

	Crude ore	Gold	Silver	Copper	Lead
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Dry gold	109	422.70	762	31	
Dry silver	5,133	1,222.17	578,423	4,950	4,130
Copper	30,287	1,448.19	45,592	4,175,046	
Copper-lead	83	44.87	2,788	7,684	35,090
Lead	15,737	1,470.54	209,160	47,882	7,690,473
	51,349	4,608.47	836,725	4,235,593	7,729,693

Average content

	Fine ounces per ton	*Fine ounces per ton*	*Per cent*	*Per cent*
Dry gold	3.88	6.99		
Dry silver	.24	112.69	0.05	0.04
Copper	.05	1.51	6.89	
Copper-lead	.54	33.59	4.63	21.14
Lead	.09	13.29	.15	24.43
Average	.09	16.29	4.12	7.53

MINING INDUSTRY

Mining in California in 1923 was carried on at approximately the same rate as in 1922, though there were some changes in relative productivity of the different counties. In 1922 there were eight counties that each produced gold, silver, copper, lead, and zinc valued at more than $1,000,000; in 1923 only seven. The production of Sierra County dropped from $1,767,726 in 1922 to $884,298 in 1923. Amador County remained in the million-dollar class, though its output was more than $500,000 less than in 1922, because of the decreased production at the Kennedy, Argonaut, and Plymouth mines. Plumas County still held first rank in the value of output, about 89 per cent of which was in copper. Yuba County took second place, with an output of gold and silver almost entirely from dredges. San Bernardino County, whose output was mostly silver, ranked third. The increased production of gold by the dredges was more than offset by a decrease from the deep gold mines, particularly in Sierra County, in Amador County on the Mother Lode, and in the Grass Valley district of Nevada County. The operators of deep gold mines are all facing the problem of higher costs, due to the increasing depth of their mines, although the tenor of the ore seems to be maintained. Copper mining was more active during 1923. The Engels and Walker mines, in Plumas County, continued operations on a considerable scale. The Mammoth and Mountain copper mines, in Shasta County, were reopened, but the low price of copper did not permit the Mountain Copper Co. to operate long. The Island Mountain Copper Co. operated its property, and the Calaveras Copper Co., at Copperopolis, started production. The producers of silver and lead ore increased their activities in spite of their forebodings that the end of the price of $1 an ounce for silver would make it necessary to discontinue operations. The California Rand Silver remained the premier source

of silver in the State. The flotation mill[2] built at this mine was a distinct success and has made possible the treatment of much crude ore that could not stand shipment and smelter charges. The Darwin and Tecopa lead-producing districts were much more productive than in 1922, notwithstanding the fact that some of the lead mines were not operated.

Mining on the Mother Lode was not so active as in 1922. Fewer mines were productive, and there were not so many attempts made to reopen old properties.

Gold and silver produced at gold mills in Mother Lode counties in California in 1923[a]

County	Ore treated (short tons)	Gold and silver recovered in bullion			Concentrates produced (short tons)[b]
		Gold (fine ounces)	Silver (fine ounces)	Average value per ton of ore	
Amador	212,184	69,745.63	14,854	$6.86	2,682
Calaveras	173,630	36,108.88	4,379	4.32	5,084
Eldorado	388	675.49	120	36.24	
Mariposa	12,612	6,347.68	1,703	10.51	76
Tuolumne	3,309	2,796.76	467	17.59	105
	402,123	115,674.44	21,523	5.99	7,947

County	Gold and silver recovered from concentrates			Value of total recovery	
	Gold (fine ounces)	Silver (fine ounces)	Average value per ton of concentrates	Total	Average per ton of ore
Amador	12,726.16	3,387	$99.12	$1,719,798	$8.11
Calaveras	12,799.30	2,399	52.43	1,016,580	5.91
Eldorado				14,062	36.24
Mariposa	385.63	331	108.47	140,858	11.17
Tuolumne	154.80	10	30.55	61,405	18.56
	26,065.89	6,127	68.44	2,952,703	7.34

[a] Tailings excluded.
[b] Includes only those made at gold mills.

Nevada County, particularly Grass Valley, during 1923 had the beginning of a small boom. A number of operators from Nevada took options on several properties and began development. The North Star mine had a bad year, but the Empire mine produced about as much bullion as usual. The Idaho Maryland and Brunswick mines were in operation, but the Brunswick did not remain active long. The Ben Franklin, Golden Center, Alcalde, and Newtown were productive in a small way.

Although reports indicated that the large mines of the Alleghany district had ore of remarkably high tenor, the returns show a material decrease in output as compared with 1922.

[2] Colman, M. N., Metallurgical history of the California Rand: Eng. and Min. Jour.-Press, vol. 118, pp. 175–181, 1924.

The northern counties suffered through lack of water for placer work, but Trinity County made a large gold yield, owing to the much greater recovery of her dredges. In Shasta County the chief interest lay in the reopening of the copper mines and smelters, though a number of gold mines in the French Gulch district were active. The Shasta dredge, on Cottonwood Creek, finished its work, and the American Gold Dredging Co. sold its holdings near Redding to the Gardella interests. In Siskiyou County there was little activity, as water for placer work was scarce, and the few deep mines near Happy Camp, Etna Mills, and the upper Salmon country were still in the development stages.

In southern California activity centered in the Rand district. A great deal of prospecting was done by several companies with a view to developing an extension of the remarkable silver vein system of the Kelly mine. Most of this work stopped before the end of the year without demonstrating the existence of a large silver-ore bearing area. As a matter of fact, this work confirmed the impression that the silver deposits of the Rand district are limited in lateral extent to a rather small area that is nearly all controlled by the California Rand Silver (Inc.). The increased activity about Randsburg included some revival in the gold area, and development on the gold veins in and near Kern County was under way. The Zenda mine, in the Amelia district east of Caliente, in western Kern County, produced considerable silver and gold at its newly installed cyanide plant. A minor boom was started in the Mojave district by the discovery of some rich gold ore at the Yellow Dog, and several companies started development work, but the production from the district was not large. A small revival of interest in the gold region of San Diego County was evident late in the year, though little has been heard from the developments on the Hubbard and Chariot mines, in the Julian district.

Owing to the interest in arsenic for the manufacture of insecticides, there was a great amount of prospecting for deposits carrying arsenical ores. Many engineers were in the field, but their labors were apparently unsuccessful. It seemed to be the general consensus of opinion that, although California has some arsenic deposits, most of those so far discovered are either too small or too far from transportation to make them attractive.

The dredging industry was in better shape than in 1922. Though six less boats were operated, the yield was considerably increased. Two companies either finished their work or had practically finished by the end of 1923. The 29 dredges operated dug about 59,300,000 cubic yards of gravel and produced $6,080,142 in gold and silver, which indicates a recovery of approximately 10.25 cents a yard, as compared with 8.09 cents a yard in 1922. The total production of gold by dredges since the beginning of the industry in 1896 has been $136,064,934. Of this amount the Feather River field has produced $32,378,193, the Yuba River field $49,858,959, and the American River field $31,173,777.

Mine production of gold, silver, copper, and lead in California in 1923

County	Ore and tailings treated (short tons)	Deep-mine gold		Placer gold		Total gold	
		Fine ounces	Value	Fine ounces	Value	Fine ounces	Value
Amador	212,188	82,523.84	$1,705,919	1,364.85	$28,214	83,888.69	$1,734,133
Butte	236	136.45	2,821	23,441.16	484,572	23,577.61	487,393
Calaveras	209,734	48,908.18	1,011,022	9,421.60	194,762	58,329.78	1,205,784
Del Norte	12			85.99	1,778	85.99	1,778
Eldorado	388	675.49	13,964	788.51	16,300	1,464.00	30,264
Fresno	78	48.47	1,002	847.38	17,517	895.85	18,519
Humboldt				109.33	2,260	109.33	2,260
Imperial, Orange, and Riverside [a]	972	54.49	1,126			54.49	1,126
Inyo	38,157	1,775.42	36,702			1,775.42	36,702
Kern	20,712	5,062.05	104,642	116.54	2,409	5,178.59	107,051
Lassen, Merced, and Modoc [a]	45	22.99	475	8.99	186	31.98	661
Los Angeles	59	34.54	714			34.54	714
Madera	1,170	565.94	11,699	18.16	375	584.10	12,074
Mariposa	12,612	6,733.31	139,190	130.28	2,693	6,863.59	141,883
Mono	3,661	1,676.73	34,661			1,676.73	34,661
Nevada	256,256	108,935.54	2,251,897	1,463.72	30,258	110,399.26	2,282,155
Placer	116	162.17	3,352	3,501.38	72,380	3,663.55	75,732
Plumas	477,205	7,423.23	153,452	1,036.15	21,419	8,459.38	174,871
Sacramento				64,398.13	1,331,227	64,398.13	1,331,227
San Bernardino	123,530	10,127.99	209,364	75.43	1,559	10,203.42	210,923
San Diego	25	19.48	403	20.29	419	39.77	822
Shasta	55,555	1,715.42	35,461	15,674.77	324,026	17,390.19	359,487
Sierra	50,847	41,288.45	853,508	1,192.74	24,656	42,481.19	878,164
Siskiyou	660	759.67	15,704	1,447.83	29,929	2,207.50	45,633
Stanislaus				8,456.61	174,814	8,456.61	174,814
Trinity	4,843	693.76	14,341	29,194.31	603,500	29,888.07	617,841
Tuolumne	66,630	12,336.17	255,011	335.00	6,925	12,671.17	261,936
Yuba				152,400.82	3,150,405	152,400.82	3,150,405
	1,535,691	331,679.78	6,856,430	315,529.97	6,522,583	647,209.75	13,379,013
Increase or decrease from 1922	−4,242	−111,942.70	−2,314,061	+49,474.46	+1,022,728	−62,468.24	−1,291,333

County	Deep-mine silver		Placer silver		Total silver	
	Fine ounces	Value	Fine ounces	Value	Fine ounces	Value
Amador	18,260	$14,973	219	$180	18,479	$15,153
Butte	189	155	1,952	1,601	2,141	1,756
Calaveras	8,241	6,758	681	558	8,922	7,316
Del Norte			11	9	11	9
Eldorado	120	98	106	87	226	185
Fresno	10	8	146	120	156	128
Humboldt			15	12	15	12
Imperial, Orange, and Riverside [a]	20,410	16,736			20,410	16,736
Inyo	323,198	265,023			323,198	265,023
Kern	40,390	33,120	38	31	40,428	33,151
Lassen, Merced, and Modoc [a]	65	53	1	1	66	54
Los Angeles	7	6			7	6
Madera	653	535	7	6	660	541
Mariposa	2,034	1,668	82	67	2,116	1,735
Mono	3,805	3,120			3,805	3,120
Nevada	37,092	30,415	145	119	37,237	30,534
Placer	24	20	338	277	362	297
Plumas	297,421	243,885	104	85	297,525	243,970
Sacramento			3,129	2,566	3,129	2,566
San Bernardino	2,714,572	2,225,949	12	10	2,714,584	2,225,959
San Diego	173	142	3	2	176	144
Shasta	56,445	46,285	1,733	1,421	58,178	47,706
Sierra	7,368	6,042	112	92	7,480	6,134
Siskiyou	135	111	228	187	363	298
Stanislaus			1,016	833	1,016	833
Trinity	5,142	4,216	1,951	1,600	7,093	5,816
Tuolumne	3,384	2,775	32	26	3,416	2,801
Yuba			8,244	6,760	8,244	6,760
	3,539,138	2,902,093	20,305	16,650	3,559,443	2,918,743
Increase or decrease from 1922	+458,686	−178,359	+692	−2,963	+459,378	−181,322

[a] Counties combined to avoid disclosure of individual output.

Mine production of gold, silver, copper, and lead in California in 1923—Contd.

County	Copper		Lead		Total value
	Pounds	Value	Pounds	Value	
Amador					$1,749,286
Butte					489,149
Calaveras	1,598,726	$235,013			1,448,113
Del Norte	5,250	772			2,559
Eldorado					30,449
Fresno					18,647
Humboldt					2,272
Imperial, Orange, and Riverside [a]	6,553	963	54,851	$3,840	22,665
Inyo	73,518	10,807	9,487,584	664,131	976,663
Kern					140,202
Lassen, Merced, and Modoc [a]					715
Los Angeles					720
Madera					12,615
Mariposa					143,618
Mono					37,781
Nevada					2,312,689
Placer					76,029
Plumas	22,866,339	3,361,352			3,780,193
Sacramento					1,333,793
San Bernardino	12,475	1,834	6,957	487	2,439,203
San Diego					966
Shasta	3,478,598	511,354			918,547
Sierra					884,298
Siskiyou			288	20	45,951
Stanislaus					175,647
Trinity	276,300	40,616			664,273
Tuolumne					264,737
Yuba					3,157,165
	28,317,759	4,162,711	9,549,680	668,478	21,128,945
Increase or decrease from 1922	+5,778,274	+1,119,881	+3,237,144	+321,289	[b] −203,223

[a] Counties combined to avoid disclosure of individual output.
[b] Of this amount, $171,738 represents the decrease in zinc.

Placer output of gold and silver in California in 1923

County	Dredges		Drift		Hydraulic		Surface		Total value
	Gold	Silver	Gold	Silver	Gold	Silver	Gold	Silver	
		Fine ounces		*Fine ounces*		*Fine ounces*		*Fine ounces*	
Amador					$18,194	130	$10,020	89	$28,394
Butte	$391,136	1,412	$75,291	425			18,145	115	486,173
Calaveras	143,398	391	31,788	162	2,694	14	16,882	114	195,320
Del Norte							1,778	11	1,787
Eldorado			1,200	4			15,100	102	16,387
Fresno							17,517	146	17,637
Humboldt					244	2	2,016	13	2,272
Kern							2,409	38	2,440
Madera							375	7	381
Mariposa							2,693	82	2,760
Merced							186	1	187
Nevada			28,384	139	264		1,610	6	30,377
Placer	46,528	200	19,322	93			6,530	45	72,657
Plumas			11,845	44	6,814	32	2,760	28	21,504
Sacramento	1,323,315	3,099					7,912	30	1,333,793
San Bernardino							1,559	12	1,569
San Diego							419	3	421
Shasta	286,337	1,506	78	2			37,611	225	325,447
Sierra			5,173	39	18,609	63	874	10	24,748
Siskiyou					27,139	205	2,790	23	30,116
Stanislaus	173,897	1,010					917	6	175,647
Trinity	561,612	1,745			37,185	177	4,703	29	605,100
Tuolumne			6,732	31			193	1	6,951
Yuba	3,139,512	8,206	4,958	16	685	3	5,250	19	3,157,165
	6,065,735	17,569	184,771	955	111,828	626	160,249	1,155	6,539,233
Increase or decrease from 1922	+1,066,520	+961	−67,855	−436	−46,447	−280	+70,510	+447	+1,019,765

REVIEW BY COUNTIES

AMADOR COUNTY

During 1923 there were 21 deep mines and 12 placer mines producing in Amador County, as compared with 14 deep mines and 11 placers in 1922. The value of the total output of the county was $524,101 less than in 1922, and the value of the placer production was $7,491 less. Of the total placer gold produced 64 per cent was saved at 3 hydraulic mines and 36 per cent at 9 surface operations. No drift mines reported production.

The deep mines of Amador County produced dry gold ore from which were recovered gold and silver having a total value of $1,720,892, or approximately $8.11 a ton. The figures show a decrease of 38 per cent in quantity of ore and of 23 per cent in value of metals recovered, as compared with 1922. These mines were the largest producers of gold and silver in the Mother Lode counties in 1923, as they were in 1922. Practically all the ore produced in Amador County is first treated by amalgamation, usually followed by concentration. At the Argonaut mine the tailings are further treated by cyanidation. Gold mills treated nearly all the ore and recovered gold and silver in bullion, mainly by amalgamation, though about 3,000 ounces of gold and 900 ounces of silver was recovered by cyanidation.

At Amador City the Fremont-Gover mine was operated by the Metal Exploration Co. until August 11, after which the Fremont-Gover Mines Co. continued operations until the end of the year, reaching a depth of 3,000 feet. Milling was begun in March at the 30-stamp plant. Operations were finally suspended early in 1924, as it was determined that the low grade of the ore and metallurgic losses made profitable exploitation impossible. A small quantity of bullion was recovered by pocket hunters in the district.

A small amount of gold was saved by surface mining in the vicinity of Ione, but no deep mining was in progress.

At Jackson the Kennedy, Argonaut, Moore, and Amador Queen mines were the largest producers, though bullion was shipped from 13 operations in the district. The total production of the district was nearly $959,000. The Argonaut mine was finally cleared of water about the middle of the year, and the lower levels of the Kennedy were open about the same time. Since then both properties have been steady producers. The new surface equipment at the Argonaut includes a reversible fan and a concrete-lined shaft to a depth of 40 feet. The Kennedy also installed larger ventilation equipment and deepened the shaft an additional 150 feet to the 4,300-foot level. The Moore mine was opened to a depth of 750 feet, and reports state that at 640 feet 7 feet of $15 ore was encountered. The plan contemplated opening of levels at 800 and 950 feet. The 20-stamp mill was operated eight months but was shut down in the spring and early summer. The company proposes to install cyanide equipment to re-treat its tailings, which are said to carry $2 a ton, Lessees on the Amador Queen No. 2, Empire, and French Hill mines made a fair production, and the Peolay ranch, Setting Sun, and Valparaiso properties were worked in a small way.

At Pine Grove the Ludekens hydraulic mine was in operation for eight months and made a fair recovery from the 8,500 cubic yards of gravel moved. The Perini hydraulic property, near by, was also productive.

The Plymouth Consolidated mine was practically the only producer in the vicinity of Plymouth, though a minor amount of gold was sent to the mint by gravel and quartz prospectors in this district. The Plymouth mine is developed to a depth of 4,000 feet, of which 200 feet was sunk during 1923, and considerable prospecting was done. Milling was done at one-third capacity throughout most of the year. It is understood that in the fall good ore was discovered in some new ground at the lower levels.

At Sutter Creek the Central Eureka mine was operated throughout the year. A new steel head frame, electric hoist, and extensive ventilation system were installed. The shaft was sunk to the 4,250-foot level, where ore was developed. Milling was done at the rate of 900 to 1,100 tons of ore a week. The American mine, 6 miles east of Sutter Creek, was reopened late in the year by local people.

At Volcano the Elephant hydraulic mine was worked by lessees for four months, during which about 40,000 cubic yards was handled. The Defender quartz mine was worked under lease, and a few tons of ore was milled as a test run. The Marklee mine was reopened, and the shaft was retimbered to the 160-foot level.

BUTTE COUNTY

During 1923 there were 4 deep mines and 23 placer mines producing in Butte County, as compared with 2 deep mines and 15 placer mines in 1922. The placer production of gold and silver had a total value practically the same as in 1922. Four dredges were operated, yielding 81 per cent of the total placer gold, 8 drift mines produced 15 per cent, and 11 surface mines 4 per cent. The placers of the Oroville field were the most productive in the county, and the dredge of the American Gold Dredging Co. and the two boats of the Natomas Co. were the largest contributors to the total gold output. The annual report of the Natomas Co. states:

> The two dredges in the Feather River field operated the greater portion of the year on land owned by the American Gold Dredging Co. under a profit-sharing agreement, yielding a profit to us of $31,125.18. * * * It was expected that these two dredges would go out of commission during 1923, but by careful operation they can probably be made to last through the year 1924.

An interesting method of recovering gold has been in progress above Oroville, where a diving outfit has been used by Knapp & Silverstick to work in conjunction with a small suction hose for mining the gold from the bottom of Feather River.

The Highland Chief and Kelly Hill drift mines, near Magalia, made a small production, and considerable development work was undertaken with a view to the reopening of the old Magalia channel. The Emma and Oro Fino drift mines, near Nimshew, were worked, and the Lucky John and Wagstaff drift properties, near Paradise, produced some gold.

There were four productive deep mines in Butte County, whose output had a total value of $2,976, as compared with an output from

deep mines in 1922 valued at $1,579. The deep mines operated in 1923 were the Triumph, Banner, June Bug, and Bonanza King, in the area near Yankee Hill and Pulga, northeast of Oroville. The operations were little more than prospecting, but progress in the work at the Triumph mine was reported.

CALAVERAS COUNTY

In Calaveras County during 1923 there were 18 productive deep mines and 26 placer mines, as compared with 17 deep and 16 placer mines in 1922. The value of the total output showed a moderate increase.

The value of the gold and silver produced from placer mines was but slightly more than in 1922. Two dredges produced 74 per cent of the placer gold, 4 drift mines 16 per cent, 17 surface placers 9 per cent, and 3 hydraulic mines 1 per cent.

Dry gold ore yielded all the gold and 82 per cent of the silver produced from deep mines in the county. The great bulk of the copper ore mined was concentrated and yielded 59 per cent of the copper produced in the county. The remainder of the copper was derived from smelting ore and as cement copper from mine waters.

At Altaville the drift operations of the Victor Land & Mineral Co. were continued, and considerable bullion was saved. The cemented gravel from the old channel at this property is milled, and it is planned to install concentrating equipment to save the black sands, which are reported to be valuable. A small quantity of ore treated at the Port Arthur stamp mill yielded a little bullion and some concentrates.

At Angels Camp prospecting was under way at several properties and a little gold was recovered, but no regular mining was done. The Triple Lode mine was not operated.

At Camanche testing of properties controlled by the Camanche Gold Dredging Co. resulted in saving some bullion. A Risdon dredge with 69 buckets of 4 cubic feet was placed on the property late in the year. Over 100 ounces of gold that resulted from the work of prospectors and snipers was sold through merchants at Camanche.

At Campo Seco the copper property of the Penn Mining Co. remained closed, but cement copper was produced from mine waters. A little placer bullion was produced by prospectors in this vicinity.

At Carson Hill is the largest mining enterprise in Calaveras County, the Carson Hill Gold Mines, which now controls the Morgan, Melones, and Calaveras groups. The mines were operated full time during 1923 on what reports say was high-grade ore. The ore is amalgamated, and the concentrates and tailings are treated by cyanidation. A small quantity of mill bullion and placer gold was produced by prospectors in the vicinity of Carson Hill.

The Calaveras Copper Co., at Copperopolis, after several months of preparation, began production in June and continued in operation the rest of the year. The total output was 35,957 tons of ore, 99 per cent of which was milled in the 400-ton flotation plant. Ore and concentrates are smelted at Copperopolis, and the blister and matte are sent to Tacoma for refining. The production in 1923 was nearly 1,500,000 pounds of copper. A new hoist was installed at the main

shaft, which is now down to the 1,400-foot level. Some gold was saved by sluicing at the Empire placer mine, near Copperopolis.

Bullion was produced from ore extracted during development work at the Gold Knoll and Royal mines, in the Felix district.

Near Fourth Crossing the Bachman property was prospected by J. E. King under bond and lease.

At Jenny Lind the Isabel dredge, on Calaveras River, was successfully operated throughout the year, and a small quantity of placer gold was recovered by prospectors.

Near Mokelumne Hill the Morning Star, Lamphear, and Eazybird quartz mines were under development, and a small quantity of gold was recovered in testing the ore of these properties. Gold was also recovered at several small placer operations in the region.

The Shenandoah quartz mine, near Mountain Ranch, was prospected, and the Pilot and Lucky Girl mines, at Cave City, 3 miles south of Mountain Ranch, were under development. At both operations some gold was saved. The Glenn hydraulic property, at the head of Salamander Gulch, east of Mountain Ranch, was worked for two months.

At San Andreas the Ford (Apex) mine was under development, but no ore was milled in 1923. The old shaft was unwatered to the second level, and drifting was begun on the first level. It is reported that a wide vein carrying some high-grade ore has been opened.

At Sheepranch several properties, among them the old Calaveras, Enchantress, and Oro Minto, have been bonded to the Mar-John Co., and late in 1923 A. G. Frazier started development on the Washington mine. Cobalt-bearing arsenopyrite ore was discovered on one of the claims of the Mar-John Co.

A small amount of placer bullion was saved by miners working in a small way near Valley Springs. A new development was begun at Wallace, west of Valley Springs, early in 1924 by the Hesperides Mining Co., which will supply sand and gravel for road and concrete work but will also make a by-product of gold in the washing and screening of the raw material.

At West Point the Banner, Columbus, and Lone Star quartz mines were productive, but apparently all work on the deep mines of the district was discontinued before the end of the year. The largest producer was the Lone Star mine, at which the shaft was 400 feet deep and the 25-ton mill was equipped for amalgamation and concentration. A small quantity of placer gold was sold through merchants at West Point and presumably originated from prospectors working in that vicinity. The Lone Point and Victor quartz prospects were developed.

COLUSA COUNTY

No mines in Colusa County reported production in 1923. The Manzanita or Cherry Hill mine, also known as the Siereci, at Wilbur Springs, was taken under lease and bond by the Western Mining & Development Co., and considerable work was done.

DEL NORTE COUNTY

One deep mine and two placer mines were productive in Del Norte County in 1923, as compared with one placer in 1922. From the Union group, in the Smith River district, a small lot of copper ore, carrying arsenic, was shipped to Tacoma, and placers near Requa and Crescent City contributed to the gold and silver output of the county.

ELDORADO COUNTY

There were 14 deep mines and 14 placer mines operating in Eldorado County in 1923, as compared with 12 deep and 12 placer mines in 1922. The total value of the gold and silver produced in the county showed a decrease of $17,267, or more than one-third.

The 12 surface placer mines operated in the vicinty of El Dorado, Georgetown, Grizzly Flat, and Placerville produced most of the placer gold and silver, the remainder coming from two drift mines near Smith Flat. The total placer output in 1922 was valued at $25,246, and thus there was a decrease of 35 per cent in 1923.

The dry gold ore produced at El Dorado County deep mines in 1923 showed a decrease of 1,772 tons compared with 1922, and the yield decreased by 403 ounces of gold and 63 ounces of silver. All the bullion produced from the dry ores mined in the county was saved by amalgamation, and no concentrates or ore were shipped to the smelter.

The Hines-Gilbert mine, near Greenwood, produced some bullion from ore taken out during development work, and the Beebe mine, near Georgetown, was worked under lease for a short time. During the first few months of the year 100 tons of ore from the Ila and Edith mines, at Kelsey, was milled, giving over 100 ounces of gold. The rest of the deep-mine production came from the operations of pocket hunters at different localities along the Mother Lode belt.

FRESNO COUNTY

There were 5 productive deep mines and 2 placer mines in Fresno County in 1923, compared with 3 deep mines and 4 placer mines in 1922. The value of the total production of the county increased $8,118.

Practically all the placer gold was saved as a by-product at the sand and gravel plant of the Grant Rock & Gravel Co., at Friant, but a little gold was saved by sluicing near Auberry.

Nearly all the gold and silver from deep mines was recovered by amalgamation. The largest producer was the Dixie Queen mine, near Dunlap, and some ore was milled from the White Cross mine. The Gilroy mine, near Grabners; the Sunnyside mine, on Hughes Creek, near Delpiedra; and the Riffle mine, at Sycamore, near Sanger, were also productive.

HUMBOLDT COUNTY

The output of Humboldt County in 1923 came from a hydraulic mine on Klamath River, near Weitchepec, and three surface workings. The total value of the output was $932 more than in 1922. The chief producers were the operations near Orleans and Orick.

IMPERIAL COUNTY

The only production reported from Imperial County was that from the operations of a cyanide plant, working tailings from the Paymaster mine, near Glamis.

INYO COUNTY

During 1923 there were 30 productive deep mines in operation in Inyo County, as compared with 19 deep mines in 1922. The production in 1922, from 34,670 tons of ore, was 4,124.68 ounces of gold, 256,009 ounces of silver, 68,582 pounds of copper, 6,270,121 pounds of lead, and 58,700 pounds of zinc, valued at $698,736. No zinc was produced in 1923 and there was a decrease in gold, but increases in the other metals and in total value. The lead ore mined increased 11,458 tons, but the dry gold ore decreased 8,040 tons.

All the dry gold and silver ore was treated at gold mills. The recovery decreased, as compared with 1922, when 1,525 tons treated in gold mills yielded 655.03 ounces of gold and 188 ounces of silver.

In 1923 22,167 tons of lead ore was concentrated; in 1922 the ore concentrated, part of which was gold ore, amounted to 21,884 tons, from which were obtained 1,705 tons of concentrates that yielded 2,116.24 ounces of gold, 99,434 ounces of silver, 22,781 pounds of copper, and 1,050,230 pounds of lead. The yield in 1923 showed decreases in gold and copper but increases in silver and lead. In 1923 Inyo County mines sent to smelters 15 tons of copper ore, 25 tons of copper-lead ore, and 15,665 tons of lead ore, which yielded 1,465.34 ounces of gold, 209,844 ounces of silver, 55,115 pounds of copper, and 7,692,713 pounds of lead. This is a considerable increase, as compared with the recovery in 1922, when 11,261 tons of ore was smelted, yielding 1,353.41 ounces of gold, 156,387 ounces of silver, 45,801 pounds of copper, 5,219,981 pounds of lead, and 58,700 pounds of zinc.

Near Big Pine gold ore saved during development work at the Cometti mine produced bullion, and two small lots of lead ore were shipped to smelters. The Wilshire mine, near Bishop, was not operated but late in the year was reported to be under development by lessees. Three small lots of lead ore were shipped from this vicinity.

In the Cerro Gordo district, near Keeler, the Cerro Gordo mine was operated by the Natural Soda Products Co. under lease, and considerable lead ore was concentrated. At the Estelle mine a long lower adit, not used since 1917, was cleaned out, retimbered, and equipped for electric haulage. A new ore body was cut in this work at 7,676 feet from the portal, and development of this body was continued. The Santa Rosa was worked by lessees, who made a small production. The Pennsylvania mine shipped a small quantity of lead ore saved during development.

In the New Cosa district, near Darwin, the Argus Sterling mine shipped lead ore from work during the first four months of the year. A small shipment was made from the Christmas Gift mine. At the Darwin property A. G. Kirby, lessee, constructed a 2,200-foot tram to connect the Lucky Jim mine with the mill, the capacity of which was increased by 50 tons, and a large quantity of lead

ore was produced. The owners of the Mayflower property shipped a small lot of crude ore saved during development work. The St. George mine produced some silver ore, which was milled locally.

In the country tributary to Trona the Big Horn mine, at South Park, was operated and produced lead ore that was hauled 35 miles to the railroad. The Ophir mine, 10 miles from Trona, was worked for half the year and produced lead ore. Other producers of lead near Trona were the Otto and Wright mines. At the Slate Range mine exploration was carried on throughout the year, and both crude lead ore and lead concentrates were shipped. The Moonlight mine, 45 miles north of Trona, in Wild Rose Canyon, was worked in a small way.

Near Shoshone the Gold Treasure gold mine was under development, and a small quantity of bullion was produced. The Paddy Pride lead mine shipped a little ore that was saved in the course of assessment work.

At Tecopa considerable crude lead ore was produced at the Tecopa mines and shipped to Salt Lake smelters. The property was actively developed throughout the year.

KERN COUNTY

During 1923 there were 23 productive deep mines and 12 placer mines in Kern County, as compared with 22 deep mines and 4 placers in 1922. The value of the metals produced increased $9,341.

The output of placer gold was obtained largely from dry-washing operations near Randsburg, though a little gold was saved on Kern River near Kernville and Isabella. The placer recovery of both gold and silver was less than in 1922.

The productive deep mines of the county in 1923 gave 20,712 tons of ore, of which about one-fourth was dry gold ore and the rest dry silver ore. The yield from this ore was 5,062.05 ounces of gold and 40,390 ounces of silver, valued at $137,762, as compared with a yield of 5,876.89 ounces of gold and 6,471 ounces of silver, valued at $127,957, in 1922.

All but 100 tons of the ore mined in Kern County in 1923 was treated at gold and silver mills. Of the gold 77 per cent was recovered by amalgamation and 23 per cent by cyanidation, but of the silver 96 per cent was recovered by cyanidation.

In the Amelia district, northeast of Caliente, dry gold ores were produced at the Dead Tree, Royal Flush, and Jeanette mines. The Zenda mine was the largest operator in the district and produced dry silver ore, which was cyanided. During 1923 the milling capacity of the Zenda was increased from 50 to 150 tons a day. At the Ferris mine a 60-ton mill was installed and considerable gold ore developed.

In the Keyesville-Bodfish area some gold ore obtained in the course of development work at the Glen Olive, Pickwick, and Steamboat mines was milled. The North Sumner Gold Mines Co. developed the Beauregard and Big Blue mines, near Kernville, and considerable work was done at the Narragansett.

At Mojave there was considerable activity, but little ore was produced. The Exposed Treasure and Desert Queen mines, owned by the Standard Mining & Milling Co., and the Yellow Dog, Yellow

Dog Extension, and Elephant United properties were under development.

The gold-producing district tributary to Randsburg, which lies in Kern County, was active during 1923. The largest production came from the Yellow Aster mine, which was worked by lessees. The Big Butte and Little Butte mines made small outputs. The King Solomon mine, near Johannesburg, was leased by the North Rand Silver Mining Co., and a considerable production was made. The Phoenix and Val Verde properties were reopened by the Operator Divide Mining Co., and some ore was milled. The Schade mine, 1 mile north of Randsburg, was developed, and about 50 tons of ore was milled. Development was under way at the Big Gold, Lucky Boy, and Sidney mines. The St. Lawrence Rand lease on the K. C. N. ground was continued, and sinking was carried on. The Monarch Rand Co. did considerable development work at the White Horse shaft.

The Tropico mine, near Rosamond, produced dry gold ore which was first amalgamated and the tailings cyanided.

In the region near Woody a little dry gold ore was produced at the Blue Mountain, Casten-Jack, and Josephine mines.

LASSEN COUNTY

A small quantity of ore was mined and treated at the mill of the Juniper mine, at Hayden Hill.

LOS ANGELES COUNTY

Three deep mines in Los Angeles County—the Monte Cristo, near Acton; the Gold Dollar, at Camp Baldy; and the Big Chief, near Neenach—produced ore from which gold and silver were recovered by amalgamation.

MADERA COUNTY

One deep mine and three placer mines were productive in Madera County, and the value of their combined output was more than twice the value in 1922, when four deep mines and three placers produced 77.12 ounces of gold and 3,500 ounces of silver, valued at $5,094. The placers producing in 1923 were all small sluicing operations near Raymond, Hildreth, and Prather, and the deep mine was the Kroromick, on Potter Ridge, near Coarsegold, from which gold was saved by amalgamation, followed by concentration.

MARIPOSA COUNTY

In Mariposa County 18 deep mines and 7 placer mines were productive, as compared with 17 deep mines and 7 placers in 1922. The output decreased in value $78,254 as compared with 1922, when 10,573.37 ounces of gold and 3,301 ounces of silver were produced.

The placer mines produced less gold but more silver than in 1922. The placer gold was all recovered by prospectors, and no real placer operations were under way. The largest quantity came from prospects in the vicinity of Mariposa, Bagby, and Merced

Falls. The deep mines produced dry gold ore, practically all of which was treated by amalgamation.

The largest production was made by the Original mine, at Clearinghouse, followed by the Princeton, at Mount Bullion, and the Specimen Queen, at Bagby. The Jumper mine, at Bagby, was under development, as was the Texas Hill property, at Coulterville, where 400 feet of work was accomplished and the mill put in shape for operation. The Little Wonder mine, at Mariposa, was further prospected and developed. The Moore Hill mine, at Cathay, yielded a small output from ore obtained in the course of development work. The mine is equipped with a 25-ton cyanide plant. The Bobby mine, operated for a short period early in 1923, made a small production. The Argo group, at Coulterville, was developed, and a small quantity of high-grade ore mined incidentally to this work was milled. The Ruth Pierce mine, at Hornitos, was reopened for examination, and several hundred tons of ore was milled. Intensive development was continued at the Princeton, and over 2,000 tons of ore was milled at the newly erected 10-stamp amalgamation plant.

MERCED COUNTY

Small surface placer mines along Merced River near Snelling produced all the gold output of Merced County in 1923.

MODOC COUNTY

A small amount of bullion was shipped from a mill clean-up at the Hess mine, near Adin. It is rumored that this mine may be worked in 1924.

MONO COUNTY

Six deep mines in Mono County were productive in 1923, as compared with eight in 1922. No placer mines reported production. The value of the output was less than half the value in 1922, when 3,180.50 ounces of gold, 11,686 ounces of silver, 3,976 pounds of copper, and 9,774 pounds of lead, valued at $78,507, were produced from 1,598 tons of ore. From 1,500 tons of tailings treated by cyanidation there were recovered 107.94 ounces of gold and 693 ounces of silver, and one small shipment of high-grade ore yielded over 50 ounces of gold to the ton. The largest producer in the county was the Chemung mine, at Masonic.

At Bodie some bullion was produced from treating old tailings and a little from ore mined by lessees on the Standard properties. Several ounces of gold was saved from old Bodie tailings that have accumulated at Fletcher post office, a few miles below Aurora, Nev.

A large amount of development work was undertaken in the Blind Springs district by the Comanche Mining & Reduction Co. on the Kerrick and Diana Consolidated properties, out from Benton.

In the Homer district a small lot of ore was milled at the Parrett group, and rehabilitation of the power house and mill of the May Lundy property was in progress.

At Masonic a considerable production was made at the Chemung property, operated by the Visalia Masonic Mining Co. Five stamps were added to the mill, and equipment for cyaniding sands and

slimes was placed in operation. The Serita mine was under development.

The Mono Mining Co., operating a large group of claims in Silverado Canyon, in the Patterson district, west of Sweetwater, Nev., continued development work and made plans to erect a 100-ton all-slime cyanide plant.

MONTEREY COUNTY

None of the mines in Monterey County reported production in 1923. At the New York mine, in the Los Burros district, operated by Mr. Cruikshank, a body of arsenical sulphide ore of high gold tenor was opened 225 feet below the surface.

NEVADA COUNTY

In Nevada County 14 deep mines and 12 placer mines were productive during 1923, as compared with 15 deep mines and 11 placers in 1922. The value of the total production of the county was $610,633 less than in 1922, when the output comprised 140,460.32 ounces of gold, 19,583 ounces of silver, 420 pounds of copper, and 1,981 pounds of lead, valued at $2,923,322. The Empire and North Star mines were the largest producers in 1923.

Nine drift mines, one hydraulic mine, and two sluice mines yielded gold and silver valued at less than half the value of the placer bullion produced in 1922. The largest placer producers in 1923 were the Quaker Hill, Mark Lung, and Malakoff drift mines, at North Bloomfield, and the Liberty Hill and Swamp Angel, at Lowell Hill.

The deep mines produced a decreased quantity of dry gold ore, which yielded less gold but more silver than the ore mined in 1922. The average value of the ore mined in 1923 was $8.91 a ton, as compared with $10.63 in 1922 and $12.84 in 1921.

All the dry gold ore was amalgamated, but at the Empire and North Star properties the tailings and concentrates are re-treated by cyanidation.

At Graniteville the Republic and National mines produced ore, and development work was under way at the Mammoth property, where a 5-stamp mill was installed.

In the Grass Valley district there was much activity, and a number of properties were being developed. A number of operators from Nevada entered this district and a small boom developed, though it did not get well under way until early in 1924. The chief new developments were at the Ben Franklin-Alaska group, south of Grass Valley, which was worked by the Ben Hur Mining Co., and at the Golden Center, in the town, and at the Alta Hill, north of the town, which were worked by the Harr interests. The Golden Center mine, an old property, was unwatered, and at the Alta Hill a new vertical shaft was sunk 500 feet. In the Deadmans Flat area, west of Grass Valley, several properties were under development. The chief producers of the district were the Empire, North Star, Idaho Maryland, Alcalde, and Brunswick mines. At the Empire the 80-stamp amalgamation and cyanidation plant was kept in full operation, as the development program of this mine has been large, and ore reserves are kept well ahead of mining. At the North Star milling was cur-

tailed in favor of development, and as a result the production was somewhat less, but new ore bodies were discovered between the 6,000 and 6,300 foot levels. The annual report of the North Star company states that 89,500 tons of ore was milled, with an average yield of $8.28 a ton, at an average cost of $9.29 a ton, which, however, includes $2.15 a ton for development, an unusually high figure occasioned by the extensive program carried out, the new workings aggregating 10,068 feet. The year's output was valued at $741,337, and the costs were $831,780, which included $192,032 for development work. A dividend of 2 per cent, amounting to $50,000, was paid, making the total dividends to the end of the year $5,762,040. The Idaho Maryland was worked actively, mostly in development of the lower levels, and the 20-stamp mill was completed and placed in operation. It is reported that the ore opened in the lower workings may make it necessary to enlarge the mill. The Brunswick was unwatered by April and continued in operation, with development work below the 1,350-foot level, until the middle of December, after which no mining was done, though the mine was kept free from water. At the Alcalde mine bullion was produced from a shoot on the 300-foot level, but late in the year mining was discontinued and sinking was begun.

Nevada City mines were not active, though a small quantity of ore from the Queen Lil was milled, and some placer gold was taken from two drift mines.

Near Washington the Eagle Bird quartz mine was worked under bond, and the Lucky Strike drift mine was productive.

ORANGE COUNTY

The Silverado or Blue Lights lead mine, near Anaheim, increased its output in 1923, as compared with 1922. Both crude ore and flotation concentrates, carrying lead and silver, were produced.

PLACER COUNTY

In Placer County 4 deep mines and 19 placer mines produced gold and silver, but much less than in 1922, when the output was 5,789.22 ounces of gold and 952 ounces of silver, valued at $120,625, produced by 11 deep mines and 26 placers.

The placers operated included 1 dredge, 12 drift mines, and 6 sluice operations. The output was nearly the same as in 1922. The largest yield came from the dredge near Applegate, operated by the Colfax Dredging Co., and the next largest from the Glenn drift mine, at Michigan Bluff. Most of the placer operations were small and can not be accredited to any particular mining company. The Michigan Bluff drift mines, including the Glenn, Gorman Consolidated, Muir, New Hope, and Red Star, yielded about 700 ounces of gold. From the Black Diamond and Spanish drift mines, at Forest-hill, together with the output of prospectors, a total of 175 ounces of gold was obtained. Less than 100 ounces each came from placers near Iowa Hill, Dutch Flat, and Auburn.

The ore produced by the deep mines was about 3 per cent of the quantity mined in 1922, when 4,061 tons of ore yielded 2,256.36 ounces of gold and 510 ounces of silver. The largest output came from the

Dry Hell and Blue Jay Consolidated mines, near Foresthill, though a little gold was obtained from prospecting operations on the Carlson property, near Butcher Ranch, and the Daniel Webster and Johnny Rafael properties, at Michigan Bluff.

PLUMAS COUNTY

In 1923 there were 13 deep mines and 18 placer mines in operation in Plumas County, as compared with 7 deep mines and 22 placers in 1922.

The total production of the county in 1923 was not very different from the output in 1922, showing a decrease in gold, a very small gain in silver, a larger increase in copper, and a gain of $468,415 in total value.

The value of the output from 4 drift, 3 hydraulic, and 11 sluice mines in 1923 was about one-fourth that of the output of 5 drift, 4 hydraulic, and 13 sluice mines in 1922. The largest placer producer in 1923 was the Marguerite (Feather Forks) drift mine, near La Porte, and the next was the Curtner hydraulic mine, on Grizzly Creek near Genesee. Small operations of drift and sluice mines near Seneca resulted in saving less than 75 ounces of gold. The La Porte district can be credited with about 720 ounces of gold, and the Taylorsville-Crescent Mills district with about 50 ounces of gold.

The deep mines of Plumas County produced ore which carried gold, silver, and copper valued at $528,488 more than the output in 1922, when 438,836 tons of ore yielded 6,866.26 ounces of gold, 296,764 ounces of silver, and 20,677,771 pounds of copper, valued in all at $3,230,201. The dry gold ore mined in 1923 had an average value of $6.78 a ton, and the copper ore an average value of $7.88 a ton.

Practically all the dry gold ore produced was treated at amalgamation mills. Flotation and concentration mills handled most of the copper ore. The Engels and Walker copper mines were the largest producers in the county, and the Jamison mine, at Johnsville, was the largest producer of dry gold ore.

In the Engels district copper ore was shipped from the Iron Dyke, Bearsley, Ruby, Starlight, and Engels mines. Except those from the Engels, all these shipments were small and resulted from development work and testing. The Engels Copper Mining Co.'s annual report shows that the production in 1923 was 14,450,243 pounds of copper, 165,441 ounces of silver, and 2,592 ounces of gold, whose gross value was $2,456,201.88. Costs are stated as 11.35 cents a pound, after crediting gold and silver, and 12.93 cents a pound after adding reserves for depreciation, compensation, insurance, and amortization. The net cost of copper on cars at the mine was 7.47 cents a pound, and the cost of marketing 3.88 cents a pound. Mining costs were $1.67 a ton, and milling costs 83 cents a ton. Development charges for 1923 were $96,790, which paid for 4,056 feet of workings, over half of which was in the No. 10 tunnel level, which was practically completed. The ore reserves in the Engels mine comprise 1,753,418 tons of ore carrying more than 2 per cent of copper, of which 233,375 tons is broken, 873,243 tons is in place, and 646,800 tons is estimated as probable. These figures do not include all the ore between the No. 7 and No. 10 levels, though the extent of this ore is fairly well known. In the Superior mine the

reserves amount to 816,647 tons, of which 416,850 tons is in place, 149,797 tons broken, and 250,000 tons probable. The Superior mill during 1923 treated 381,420 tons of ore carrying 2.135 per cent of copper and made an average recovery of 88.737 per cent, the highest being 92.15 per cent in May. The product was 24,920 tons of concentrates, assaying 28.99 per cent of copper.

At the Walker copper mine, on Grizzly Creek, north of Spring Garden, a new 750-ton flotation mill was built and operated. A considerable amount of development work resulted in opening large ore reserves north of the main ore body. The annual report of the Anaconda Copper Mining Co. states that 87,041 tons of ore from the Walker mine, averaging 4.123 per cent of copper, was milled and produced 14,566.64 tons of concentrates averaging 22.782 per cent of copper, of which 14,087.28 tons, containing 6,634,368 pounds of copper, was shipped, as well as 7,591.37 tons of crude ore, averaging 9.75 per cent of copper. A description of this mine and the new milling plant has been recently published.[3]

RIVERSIDE COUNTY

Two deep mines in Riverside County reported production in 1923; there were none in 1922. The Meleta group, out from Mecca, shipped copper-lead ore, and the Desert Queen mine, in the Pinon district, near Banning, milled some dry gold ore. The Gold Rose mine, in the Dale district, 45 miles north of Mecca, was further developed.

SACRAMENTO COUNTY

There were 14 placer operations in Sacramento County in 1923. The total production was practically the same as in 1922, the value being only $20,348 less. By far the largest production of the county came from the six dredges at Natoma operated by the Natomas Co. of California, whose annual report states that the gross returns in this field were 9.86 cents a yard, being the best since 1915. The No. 10 dredge finished its ground and will be rebuilt on other holdings in the same field.

SAN BERNARDINO COUNTY

In San Bernardino County 19 deep mines and 10 placer mines contributed to the metal output in 1923, as compared with 22 deep mines in 1922. The total production showed considerable increases in gold and silver, a slight decrease in copper, and a decrease of nearly one-half in lead; the total value was $63,931 less than in 1922.

The placer output was obtained from dry-washing operations near Randsburg and Barstow. The deep mines produced nearly twice as much ore as in 1922, but the value of the metals obtained from the ore was $65,500 less. The ore mined was mainly dry silver ore, the yield from which was valued at $2,410,367; dry gold ore yielded $25,453, and lead ore $835; 450 tons of tailings were cyanided. The California Rand Silver was the largest producer of silver ore in the State, and the Black Hawk mine, at Randsburg, was the largest producer of gold ore in San Bernardino County.

[3] Young, G. J., Anaconda Walker mine and mill: Eng. and Min. Jour.-Press, vol. 117, pp. 723–730, 1924.

Besides the dry gold and silver ore treated at gold and silver mills, 114,223 tons of silver ore was concentrated, and smelters received direct from the mines 36 tons of gold ore, 5,133 tons of dry silver ore, 18 tons of copper ore, and 59 tons of lead ore.

In the Calico and West Calico districts a small production of gold, silver, and lead was reported from the Klondike, Oriental, Silver Bow, Silver King, and Sioux mines. Part of the silver was recovered from tailings treated at the Sheridan and Sioux mines. The largest silver output was derived from oxidized ore shipped from the Silver King.

The Minnehaha group, near Camp Baldy, milled several hundred tons of dry gold ore.

Two mines near Cima shipped ore in 1923—copper ore from the Mammoth and lead ore from the Joshua G.

Some dry gold ore mined at the Gateway property, on Fremont Peak, southeast of Osdick, was milled at the Black Hawk mill. Gold ore was mined at the Black Hawk and Davenport mines, in the Rand district, and silver ore was shipped by the California Rand Silver and Silver King No. 2. A large number of companies, mostly operators from Nevada, were developing properties surrounding the Kelly silver mine. At one time as many as 25 shafts were being sunk in the supposed silver area. By winter much of this prospecting had been abandoned, and the threatened litigation between the California Rand and Coyote mines had been settled, so that the district settled down to a more solid basis of work on the big property. The annual report of the California Rand Silver states that a promising ore body has been developed in the seventh level of the No. 6 shaft, but that no commercial ore has been encountered in the lower workings (fourteenth level) of the main shaft. During the year 114,223 tons of ore, having an average value of $17.62 a ton, was milled and produced 6,918 tons of concentrates having a gross value of $1,747,701.96. In addition 5,013 tons of smelting ore, valued at $526,821.46, was shipped. The gross value of the ore produced was $2,277,523.42. Marketing expenses, including treatment and freight, amounted to $374,737.41. Disbursements, including dividends of $691,200, were $1,781,464.95. Early in 1924 the California Rand Silver (Inc.) decided to suspend payment of the regular monthly dividends of 2 cents a share and to devote more money to a development campaign in order that ore reserves could be provided to keep the 400-ton mill in most efficient operation. The total dividends paid by this company during the four years of its productive life have been $3,018,400.

The Big Bear Mining Co. operated the Gold Mountain mine, in the Pine Knot district, for a short time under lease and milled some gold ore.

SAN DIEGO COUNTY

Two deep mines and four placer mines in San Diego County produced gold and silver in 1923. In 1922 the output from this county was nominal. The placer gold saved in 1923 came largely from small operations in the Julian district, and the deep gold from the Hubbard quartz mine, near Descanso.

SHASTA COUNTY

In Shasta County 10 deep mines and 17 placer mines reported a production of gold, silver, and copper in 1923. The output in 1922 was 19,012.99 ounces of gold, 26,901 ounces of silver, 1,733,424 pounds of copper, and 2,954,250 pounds of zinc, valued at $822,339, produced by 18 placers and 18 deep mines.

The placer mines in 1923 included 3 dredges, 1 drift mine, and 13 sluice operations, which yielded bullion carrying $5,872 more in gold and silver than the placer yield in 1922. The largest producers of placer gold in 1923 were the Gardella dredge, on Clear Creek; the Shasta dredge, on Cottonwood Creek; and the American dredge, near Redding. The Shasta boat finished its ground during the year and will be dismantled. The American dredge was moved to new ground late in the year, but early in 1924 it was reported that the Gardella interests had acquired the property and that the American Co. would abandon dredging. The total dredge output of the county was valued at $287,572. The rest of the placer production came from small operations near Bayles, French Gulch, Platina, Redding, and Shasta.

The deep mines yielded nearly twice as much ore and tailings as in 1922, when the production was 3,632.99 ounces of gold, 25,259 ounces of silver, 1,733,424 pounds of copper, and 2,954,250 pounds of zinc recovered from 28,353 tons of materials. The dry gold ore was practically all treated at amalgamation mills. Part of the copper ore was concentrated, and part was smelted direct. The recovery from the ore, concentrates, and pyrite cinder smelted was 1,128.60 ounces of gold, 56,330 ounces of silver, and 3,478,598 pounds of copper.

More development work was in progress in the French Gulch district than in 1922, and several hundred tons of dry gold ore, the result of work at the Milkmaid, Brown Bear, Sybil, and Niagara mines and at several surface operations, was milled locally. Prospectors operating in the Redding, Shasta, and Whiskeytown districts also produced dry gold ore. The Chicago silver mine, at Igo, installed electrically driven equipment and continued development.

The Balaklala, Mammoth, and Keystone mines of the U. S. Smelting Co. were placed on a producing basis, and two furnaces of the smelter at Kennett were blown in late in the year on company ore. The Mountain Copper Co. reopened its Iron Mountain mine, and in August its copper smelter at Martinez was blown in. Owing to the low price of copper, however, smelting was discontinued in December, and the Iron Mountain mine was closed, though the Hornet mine was still producing sulphide ore for the preparation of sulphuric acid. The Afterthought mine was sold under foreclosure proceedings to the bondholders of the old company, and it was rumored that the mine would be reopened, though up to the end of the year nothing was done at the mine.

SIERRA COUNTY

In Sierra County 16 deep mines and 21 placer mines reported a production of gold and silver in 1923, valued at about half as much as the output from 16 deep mines and 16 placers in 1922.

Of the production from placer mines, which amounted to about two-thirds as much as in 1922, 75 per cent was made by 4 hydraulic mines and 21 per cent by 12 drift mines. The largest producers of placer gold were the Brandy City and Depot Hill hydraulic mines. The Midas and Mount Alta placers, at Alleghany, and the Monte Christo and Pilot placers, near Downieville, yielded a little gold. At Forest the Lucky Dog, Mugwump, and Wisconsin drift mines were productive. Considerable preparatory work was undertaken by the Scales Syndicate, which took over a number of the gravel properties on the Scales-Port Wine channel. There was a small production by placer miners at Gibsonville, Goodyears Bar, Sierra City, and Table Rock.

The deep mines of Sierra County produced dry gold ore that carried gold and silver valued at $859,550. This is a considerable decrease as compared with the output in 1922 and reflects the uncertainty of mining in the type of high-grade pocket deposits characteristic of Sierra County. There was much activity in the Alleghany-Forest district, however, and several new companies worked the field. The largest production was made by the Sixteen to One mine, followed by the Tightner, Plumbago, Rainbow, and Irelan mines. The Eldorado, Kanaka, Morning Glory, and Oriental mines were small producers. Information concerning the operation of the large producers in this district is not given out. The Sixteen to One Co. made several additions to its mill and did considerable development work. Early in 1924 it was reported that the Tightner mine had been sold to the Clark interests, who control the Alleghany Mining Co. The Plumbago mine was bonded by the Ante-Up Mining Co. in March, 1923, and considerable development was done after the change. The Rainbow mine was operated under bond by the North Star Mines Co., and some ore was produced incidentally in the course of extensive development work. The Kate Hardy mine, near Forest, made some production in the fall, and considerable development work was done at the Contact group, operated by the Sierra Gold Mining Co. At Downieville there was some activity in quartz mining, but the Bessler and Ironsides were the only quartz properties reporting production. The Four Hills mine, out from Johnsville, Plumas County, continued to produce dry gold ore.

SISKIYOU COUNTY

During 1923 there were 13 deep mines and 49 placers in operation in Siskiyou County, which reported a somewhat smaller production of gold and silver than was obtained from 23 deep mines and 37 placers in 1922, but the output of 288 pounds of lead in 1923 was a gain, as in 1922 no lead was produced.

Of the yield from placer mines 91 per cent was won by hydraulic methods. The total value of the placer yield was $2,471 less than in 1922. The largest placer operations in 1923 were near Sawyers Bar, on Salmon River. All operators reported low water, and little real mining was done, though preparations for running, if water should be available, were made at several places. Near Cecilville the Banner, Jefferson, and Summerville hydraulic mines had water for only short runs. The Bennett Co. and the Forks of Salmon Co., near Forks of Salmon, had a poor year. At Hamburg the

Dick Morris, Kunz, and Nigger Creek mines were productive in a small way. The Davis Consolidated, at Happy Camp, made practically no output, owing to slide and low water, but about 50 ounces of gold was produced from mines in the vicinity. At Sawyers Bar the John Frank placers, operated by Jay Woodfill, and the Eddy Gulch hydraulic properties, after extensive preparations for work, had water for only short runs, and the total placer gold recovered in the district was less than 400 ounces.

Thirteen deep mines reported the production of dry gold ore carrying gold, silver, and lead having a total value of a little more than one-third that of the yield from deep mines in 1922. All the ores were treated at amalgamation mills. The largest production came from the Independence mine, near Happy Camp, worked by Zachary & Macauley. The Buzzard Hill mine and the Advance properties, near the same place, were under development, but no ore was milled. The Ball mines, near Rollin, were operated under lease and produced some bullion. The Live Oak mine, near Fort Jones, opened in 1923, was developed and produced some dry gold ores. The McKinley group was under development, and a few tons of ore from it was milled in May.

STANISLAUS COUNTY

Five placer mines in Stanislaus County reported a production of gold and silver in 1923 about 66 per cent greater than in 1922, when the output was 5,079.12 ounces of gold and 614 ounces of silver, valued at $105,609. The principal producer in 1923 was the La Grange Dredging Co., though a little gold was recovered by sluice operations near Knights Ferry.

TRINITY COUNTY

In Trinity County 5 deep mines and 42 placers reported production in 1923, showing increases of 21,039.4 ounces in gold, 4,661 ounces in silver, and 234,178 pounds in copper, as compared with the output of 8 deep mines and 31 placers in 1922.

The placer output was made by 30 hydraulic mines, 8 surface mines, and 4 dredges, and the total value was 3.6 times as much as that of the placer yield in 1922. This great increase was due to the much greater production of the dredges, which gave 93 per cent of the total placer yield. The operating dredges were those of the Lewiston Co., Trinity Co., and Gardella interests, near Lewiston, and the Estabrook dredge, near Trinity Center. Water was low, and in consequence hydraulic mining was not particularly active. The Dixon Bar mine, near Big Bar, and the Corona and Horseshoe Bend mines, near Burnt Ranch, made short runs. At Coffee Creek the Glacier, Steves Gulch, and Underground Treasure placer mines had water for only a few weeks' work. Near Denny the Eagle Bird and McAtee Bar mines were operated. At the McAtee Bar considerable work had been done in preparation for a good water season. Several small operations were carried on near Hayfork and Junction City. The Nugget Bar placers, near Minersville, had only a short run. A considerable quantity of gold whose origin is uncertain but which doubtless came from Trinity County mines was sold through merchants and banks at Weaverville.

The deep mines produced ore carrying gold, silver, and copper worth 2.7 times as much as the output in 1922. The increase in ore mined was practically all in low-grade pyritic ore shipped for fluxing. All the gold ore mined was treated at amalgamation mills and the copper ore was smelted. The largest producer of dry gold ore was the Five Pines mine, near Trinity Center, which was worked by lessees. The Tango property, at the same place, made a small run. The Island Copper Co. shipped pyritic copper ore for flux to the Tacoma smelter.

TUOLUMNE COUNTY

In Tuolumne County 22 deep mines and 11 placer mines reported a production of gold and silver in 1923 valued at $39,395 more than the output of 34 deep mines and 8 placers in 1922. The value of the placer yield, however, was only about 70 per cent of the value in 1922. The largest producer of placer gold was the Springfield drift mine, at Columbia, which has been under continuous development for some years. A little gold was also recovered by prospectors and drift operators in the vicinity of Table Mountain.

The deep mines produced dry gold ore which carried about 20 per cent more in gold and silver than the deep-mine output in 1922. Gold mills treated part of the ore. All the concentrates made in the county were cyanided.

Pocket miners on the Eureka and Corcoran properties, near Big Oak Flat, and three pocket hunters near Columbia made a small saving of gold. At Chinese Camp the mill of the Clio Vindicator property was rebuilt and development work continued. Two small pockets were found near Groveland, where the larger quantity of gold came from the Demartini ranch. The Tonopah Mining Co. gave up its lease on the Crystalline mine, near Jamestown, in June. The Mazeppa mine was under development. The Heslop mine, near Quartz, was operated by lessees, who built a 12-stamp mill, at which over 200 tons of ore was treated, yielding considerable bullion and 100 tons of concentrates. The Shawmut mine, at Shawmut, was operated by the Belmont Shawmut Mining Co. throughout the year, and 62,000 tons of ore was concentrated and the concentrates cyanided.[4] The mine was further developed. The Belmont Shawmut Mining Co. relinquished its option on this property early in January, 1924, and the Eagle-Shawmut Mining Co., owner, continued operations. A small quantity of ore from the O K and Rawhide mines, at Rawhide, was milled. At Sonora a small leaching plant for treating old mill tailings made a fair recovery from the McCormick mine tailings, and about 30 ounces of gold was recovered from the work of pocket hunters. At Soulsbyville, on the east belt of the Mother Lode, lessees on the Black Oak mine shipped a little dry gold ore, and some gold was produced by pocket hunters. At the Norwegian mine, near Tuolumne, a fair-sized pocket was taken out by Nelson & Gillis. Development was continued at the Casa Madera mine, at which a 50-ton mill was under construction. Work at the

[4] Logan, C. A., Ore treatment at the Belmont Shawmut mine, Tuolumne County: California State Mineralogist Eighteenth Ann. Rept. pp. 748–750, 1922.

Dead Horse mine was discontinued in July, after considerable exploration work had been done.

YUBA COUNTY

In Yuba County 25 placer operations in 1923 yielded gold and silver valued at $655,995 more than the production from 18 operations in 1922. This considerable increase was due chiefly to the increased yield of the dredges. There were eight dredges operating in 1923, two less than in 1922, as the boats of the Yuba Consolidated Gold Fields, at Hammonton, had exhausted their ground. Two drift mines were operated in 1923 near Smartville, and 14 surface placers and 1 hydraulic mine were productive. The Yuba Consolidated Gold Fields, the largest gold-producing operator in the State, had only five dredges working after September. These were working in connection with the deepening and straightening of the Yuba River canal. The Marysville dredge operated throughout the year, except for a shutdown of a few weeks in August, when repairs to the stern gantry were made. The Pacific Gold Dredging Co. finished its ground on March 10 and made its final clean up in this district. About 60 ounces of gold was recovered from placer mines near Camptonville, and about 400 ounces from drift operations on the Blue Point and School Boy drift mines, near Smartville, which were worked by lessees. The Bullards Bar dam was completed. Arrangements were made by several hydraulic mining companies on upper Yuba River, in Sierra County, to work their deposits, using the débris storage furnished by this dam. Rates for storage are stated to be 3 cents a cubic yard.

GOLD, SILVER, COPPER, AND LEAD IN OREGON

(MINE REPORT)

By James M. Hill[1]

PRODUCTION

The total value of the gold, silver, copper, and lead produced in Oregon in 1923 was 7 per cent less than the corresponding value in 1922. The loss was shared by all the metals except copper. The 55 deep mines reporting in 1923 produced 44 per cent of the gold and 98 per cent of the silver credited to the State, as compared with 35 per cent of the gold and 98 per cent of the silver produced by 44 deep mines in 1922.

The 151 placer mines operated in 1923 produced 56 per cent of the gold and 2 per cent of the silver output, as compared with 65 per cent of the gold and 2 per cent of the silver saved by the 126 placer mines operated in 1922. In 1923 three dredges produced 81 per cent of the placer gold. The production by hydraulic and surface mining decreased considerably because of the scarcity of water.

Mine production of gold, silver, copper, and lead in Oregon, 1919–1923

Year	Number of mines producing	Ore (short tons)	Gold [a]	Silver [a] (fine ounces)	Copper (pounds)	Lead (pounds)	Total value
1919	78	96,173	$977,845	111,121	2,214,815	----------	$1,514,255
1920	67	82,156	1,017,490	82,743	2,355,276	----------	1,541,051
1921	107	40,333	882,034	42,120	174,300	----------	946,639
1922	170	27,522	531,568	151,812	1,046,525	76,970	828,894
1923	206	50,385	498,008	96,322	1,283,476	27,523	767,590

[a] Includes placer production.

Placer production of gold and silver in Oregon, 1919–1923

Year	Dredge		Hydraulic and drift [a]		Surface		Total value
	Gold	Silver	Gold	Silver	Gold	Silver	
		Fine ounces		*Fine ounces*		*Fine ounces*	
1919	$296,750	2,934	$76,337	683	$7,564	53	$384,761
1920	358,864	3,939	88,604	889	3,649	25	456,407
1921	381,960	3,617	88,312	577	8,461	97	483,024
1922	269,994	2,452	58,537	393	17,606	166	349,148
1923	224,117	1,649	39,408	334	13,245	79	278,461

[a] Drift mining operations were very small in 1919, 1922, and 1923.

[1] Miss Helen M. Gaylord, of the U. S. Geological Survey, assisted in the preparation of this report.

ORE

In 1923 the deep mines produced 50,385 tons of ore, an increase of 83 per cent, as compared with 1922. The increase was largely in dry gold ore, of which 29,472 tons was mined in 1923, as compared with 6,449 tons in 1922. The quantity of copper ore mined in 1923 was 1,823 tons greater than in 1922, but the silver ore was 1,983 tons less.

All the copper ore produced in the State came from mines in Baker and Grant counties. Silver ore was produced from mines in Baker, Grant, and Lane counties. The dry gold ores came from mines in eight counties, as shown in the second table below.

Ore and metals produced in Oregon in 1923

Source	Ore		Gold		Silver	
	Short tons	Per cent	Fine ounces	Per cent	Fine ounces	Per cent
Dry gold ore	29,472	58.49	7,506.11	31.16	25,515	26.49
Dry silver ore	1,973	3.92	14.30	.05	46,234	48.00
Copper ore	18,940	37.59	3,181.98	13.21	22,511	23.37
Total deep mines	50,385	100.00	10,702.39	44.42	94,260	97.86
Total placers			13,388.75	55.58	2,062	2.14
	50,385	100.00	24,091.14	100.00	96,322	100.00
Increase or decrease from 1922	+22,863		−1,623.46		−55,490	

Source	Copper		Lead	
	Pounds	Per cent	Pounds	Per cent
Dry gold ore	3,301	0.26	857	3.11
Dry silver ore	18,221	1.42	26,666	96.89
Copper ore	1,261,954	98.32		
	1,283,476	100.00	27,523	100.00
Increase or decrease from 1922	+236,951		−49,447	

Content of dry gold ore sold or treated in Oregon in 1923

County	Ore	Gold	Silver	Copper	Lead
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Baker	26,734	5,390.54	15,208	1,298	
Coos	2	5.89	3		
Crook	28	41.00	514		702
Grant	1,543	1,334.42	9,389	2,003	
Jackson	718	321.98	302		155
Josephine	145	197.04	18		
Lane	200	94.88	44		
Malheur	102	120.36	37		
	29,472	7,506.11	25,515	3,301	857

The dry gold ore mined in 1923 contained 31 per cent of all the gold produced in the State and 70 per cent of the gold derived from deep mining. Its silver content was relatively low, and the copper and lead content almost negligible. The silver ore mined carried almost no gold but contained more than 1 per cent of the copper produced in the State. The copper ore produced constituted 38 per

cent of the total ore mined and contained 13 per cent of the gold, 23 per cent of the silver, and more than 98 per cent of the copper produced.

Value of ore mined and treated in Oregon in 1922 and 1923

Class	Ore (short tons)	Total value		Average value per ton	
		In gold and silver	In all metals	In gold and silver	In all metals
1922					
Dry gold	6,449	$143,208	$144,729	$22.21	$22.44
Dry silver	3,956	119,327	126,674	30.16	32.02
Copper	17,117	71,697	208,343	4.19	12.17
	27,522	334,232	479,746	12.14	17.43
1923					
Dry gold	29,472	176,087	176,632	5.97	5.99
Dry silver	1,973	38,208	42,754	19.37	21.67
Copper	18,940	84,236	269,743	4.45	14.24
	50,385	298,531	489,129	5.92	9.71

GOLD

The mine production of gold in Oregon in 1923 was 24,091.14 ounces, valued at $498,008, a decrease of 1,623.46 ounces and of $33,560, as compared with 1922. Baker County still maintained its lead as a gold producer, though the production from this county was 1,561.76 ounces less than in 1922. Grant County mines produced 1,814.16 ounces more gold than in 1922, but the mines in Josephine and Jackson counties fell off in gold production from 2,973.93 ounces in 1922 to 1,801.63 ounces in 1923.

The placer production of gold in 1923 was 13,388.75 ounces, valued at $276,770, which was only a little larger than the yield from deep mines. The output of placer gold from Baker and Grant counties was 88 per cent of the total placer-gold output of the State, because of the operation of the dredges in those counties. The value of gold produced by dredges was 81 per cent of the value of all gold won by placer mining and 45 per cent of the value of all the gold produced in the State.

Gold and silver produced at placer mines in Oregon in 1923, by counties, in fine ounces

County	Dredge		Hydraulic and drift		Sluice		Total value
	Gold	Silver	Gold	Silver	Gold	Silver	
Baker	[a] 10,841.66	[a] 1,649	610.67	125	25.31	4	$114,169
Coos					43.20	2	895
Curry					44.02	6	915
Douglas			17.91	1	99.88	6	2,441
Grant	[a]	[a]	108.86	28	173.66	28	130,439
Jackson			599.25	81	73.45	13	13,983
Josephine			455.13	71	154.78	17	12,680
Malheur			102.78	25	26.43	3	2,694
Wheeler			11.76	3			245
	10,841.66	1,649	1,906.36	334	640.73	79	278,461

[a] Dredge output in Baker and Grant counties combined to avoid disclosure of output of individual companies.

SILVER

The silver produced in Oregon in 1923 amounted to 96,322 ounces, a decrease of 37 per cent as compared with 1922. The greatest contributor to the silver output was the Bay Horse mine, in Baker County, at which production was lowered to permit more intensive development. Placer mines produced only 2,062 ounces of silver in 1923, nearly all of which came from Baker and Grant counties.

COPPER

The output of copper in 1923 from Oregon mines was 1,283,476 pounds, valued at $188,671, an increase of 236,951 pounds and $47,390, as compared with 1922. Baker County produced over 99 per cent of the copper mined in the State.

LEAD

Lead was recovered as a by-product from ores mined in Baker, Crook, and Jackson counties chiefly for their silver and gold content. The production in 1923 was 27,523 pounds, valued at $1,927, a decrease of 49,447 pounds and $2,306, as compared with 1922.

METALLURGIC INDUSTRY

Metallurgic recovery of metals in Oregon in 1922 and 1923

Method of recovery	Material treated	Gold	Silver	Copper	Lead
1922	*Short tons*	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Amalgamation and cyanidation	2,705	2,297.38	639		
Smelting:					
Crude ore	6,279	1,515.80	127,692	222,900	76,970
Concentrates	4,231	5,157.06	20,470	823,625	
		8,970.24	148,801	1,046,525	76,970
1923					
Amalgamation	1,552	1,150.50	796		
Cyanidation:					
Crude ore	25,454	4,736.29	13,793		
Tailings	29	114.91	1		
Smelting:					
Ore	3,645	1,181.30	56,048	107,333	27,368
Concentrates	5,450	3,519.39	23,622	1,176,143	155
		10,702.39	94,260	1,283,476	27,523

Of the ore produced 27,006 tons was treated in gold mills, from which was recovered 55 per cent of the gold and 15 per cent of the silver produced from deep mines in the State. The reports from amalgamation mills do not give data concerning the consumption of quicksilver.

Dry gold ore treated at mills equipped for concentration amounted to 1,725 tons, from which 333 tons of concentrates were produced that contained 377.92 ounces of gold, 2,377 ounces of silver, and 155 pounds of lead. Nearly all this ore was produced in Baker and Grant counties. Approximately 18,000 tons of copper ore produced in Baker County was concentrated into 5,117 tons of concentrates,

which contained 3,141.47 ounces of gold, 21,245 ounces of silver, and 1,176,143 pounds of copper.

Gold and silver produced at amalgamation and cyanidation mills in Oregon in 1923

County	Ore to gold and silver mills	Gold in bullion	Silver in bullion	Ore to concentrating mills
	Short tons	*Fine ounces*	*Fine ounces*	*Short tons*
Baker	25,730	5,201.42	13,976	18,905
Grant	157	122.09	412	800
Jackson	718	318.10	119	----
Josephine	101	50.46	5	----
Lane	200	94.88	44	----
Malheur	100	99.84	33	----
	27,006	5,886.79	14,589	19,705

Mine production of gold, silver, copper, and lead from Oregon concentrates in 1923

County	Concentrates	Gold	Silver	Copper	Lead
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Baker	5,347	3,239.39	22,083	1,176,143	----
Grant	100	276.12	1,356	----	----
Jackson	3	3.88	183	----	155
	5,450	3,519.39	23,622	1,176,143	155

Of the ore shipped direct to smelters from Oregon mines during the year 712 tons was dry gold ore, which contained 1,126.49 ounces of gold, 8,548 ounces of silver, 3,301 pounds of copper, and 702 pounds of lead. The dry gold ore shipped to smelters came from six counties, but most of it was from mines in Grant and Baker counties. From 1,973 tons of dry silver ore shipped direct to smelters the recovery was 14.30 ounces of gold, 46,234 ounces of silver, 18,221 pounds of copper, and 26,666 pounds of lead. Shipments were made largely from Baker County, but mines in Grant and Lane counties also produced silver ore. The 960 tons of copper ore sent direct to smelters came from Baker and Grant counties and contained 40.51 ounces of gold, 1,266 ounces of silver, and 85,811 pounds of copper.

Metals produced from Oregon crude ores shipped to smelters in 1923

County	Ore	Gold	Silver	Copper	Lead
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Baker	2,973	131.21	47,025	101,351	26,666
Coos	2	5.89	3	----	----
Crook	28	41.00	514	----	702
Grant	624	950.01	8,410	5,976	----
Josephine	15	36.19	13	----	----
Lane	1	1.00	80	6	----
Malheur	2	16.00	3	----	----
	3,645	1,181.30	56,048	107,333	27,368

Mine production of gold, silver, copper, and lead in Oregon in 1923

County	Ore (short tons)	Quartz gold		Placer gold		Total gold	
		Fine ounces	Value	Fine ounces	Value	Fine ounces	Value
Baker	47,608	8,572.02	$177,199	5,476.24	$113,204	14,048.26	$290,403
Coos	2	5.89	122	43.20	893	49.09	1,015
Crook, Lane, and Wheeler[a]	229	136.88	2,830	11.76	243	148.64	3,073
Curry				44.02	910	44.02	910
Douglas				117.79	2,435	117.79	2,435
Grant	1,581	1,348.22	27,870	6,283.92	129,900	7,632.14	157,770
Jackson	718	321.98	6,656	672.70	13,906	994.68	20,562
Josephine	145	197.04	4,073	609.91	12,608	806.95	16,681
Malheur	102	120.36	2,488	129.21	2,671	249.57	5,159
	50,385	10,702.39	221,238	13,388.75	276,770	24,091.14	498,008

County	Quartz silver		Placer silver		Total silver	
	Fine ounces	Value	Fine ounces	Value	Fine ounces	Value
Baker	83,084	$68,129	1,177	$965	84,261	$69,094
Coos	3	2	2	2	5	4
Crook, Lane, and Wheeler[a]	638	523	3	2	641	525
Curry			6	5	6	5
Douglas			7	6	7	6
Grant	10,178	8,346	657	539	10,835	8,885
Jackson	302	248	94	77	396	325
Josephine	18	15	88	72	106	87
Malheur	37	30	28	23	65	53
	94,260	77,293	2,062	1,691	96,322	78,984

County	Copper		Lead		Total value
	Pounds	Value	Pounds	Value	
Baker	1,277,494	$187,792	26,666	$1,867	$549,156
Coos					1,019
Crook, Lane, and Wheeler[a]	6	1	702	49	3,648
Curry					915
Douglas					2,441
Grant	5,976	878			167,533
Jackson			155	11	20,898
Josephine					16,769
Malheur					5,211
	1,283,476	188,671	27,523	1,927	767,590

[a] Counties combined to avoid disclosure of individual output.

REVIEW BY COUNTIES

BAKER COUNTY

The value of the gold, silver, copper, and lead produced in Baker County in 1923 was 72 per cent of the value of all metals produced in the State but was $60,838 less than the corresponding value for Baker County mines in 1922. The decrease was due to declines of $32,285 in the production of gold, $73,488 in silver, and $2,296 in lead. Copper increased by $47,231.

There were 22 producing deep mines and 44 placer operations in Baker County in 1923, as compared with 18 deep mines and 36 placers in 1922. The value of the deep-mine production showed an

increase of $17,230, and the quantity of gold produced by deep mines was 34 per cent greater than in 1922. The ore produced in the county amounted to almost twice as much as in 1922, but the average value of the ore mined was $9.14, as compared with $17.16 a ton in 1922. Of the total ore mined in 1923, 40 per cent was copper ore, 4 per cent silver ore, and 56 per cent gold ore. Comparable figures for 1922 are 70, 16, and 14 per cent.

The gold ore mined averaged about $4.64 a ton, practically all of which was in gold and silver. The silver ore averaged $19.13 a ton in gold and silver and $21.45 a ton in all metals, and the copper ore $4.44 in gold and silver and $14.22 in all metals.

Of the dry gold ore mined, 79 tons was sent direct to the smelter, 276 tons was treated at amalgamation mills, and 925 tons was handled at mills where amalgamation was followed by concentration. All the other gold ore was cyanided. A total of 230 tons of concentrates was made that contained 0.43 ounce of gold and 3.64 ounces of silver to the ton.

All the siliceous silver ore and 937 tons of the copper ore were shipped direct to the smelter. The greater part of the copper ore was concentrated by flotation (about 3½ into 1), and the copper concentrates averaged 0.61 ounce of gold and 4.15 ounces of silver to the ton and 11.49 per cent of copper.

Placer operations in Baker County resulted in the recovery of gold and silver to a value of $78,068 less than in 1922. The decline was due in part to the shortage of power and in part to low water and to the fact that two dredges were not in operation.

Cable Cove district.—The Imperial Eagle Mining Co. produced siliceous gold ore from the Imperial and Eagle veins, most of which was milled in the 100-ton mill, though some ore was shipped to smelters. The Baisley-Elkhorn mine was taken over by a reorganized company, known as the Baisley-Elkhorn Mining Co., and development was continued, though no ore or bullion was shipped. A description of this property was published in Mining Truth, September 17, 1923. The Herculean mine was under development by the Sumpter Valley Smelter Co.

Connor Creek district.—The Bay Horse mine, operated by the United States Metals Co., curtailed production during the first part of the year in order to push development on the lower tunnel, in which a continuation of the upper ore body has been found that carries slightly more copper than was found near the surface. Plans were made for a 100-ton flotation plant,[2] the tests indicating a high recovery both on oxidized and sulphide ores. A small amount of placer gold was recovered from the Bernard placer and along Snake River in the vicinity of Huntington.

Cornucopia district.—The Last Chance and Union mines, operated by the Cornucopia Mines Co., were worked at capacity throughout the year, and a large recovery of bullion was made at the cyanide plant. The Queen of the West mine was under development by the Gold Reef Mining Co., and a new tram from the mine to the 60-ton cyanide mill was constructed. The Golden Hand placer, on Pine Creek, was operated in a small way for about two-thirds of the year.

[2] Eng. and Min. Jour.-Press, vol. 115, p. 291, 1923.

Cracker Creek district.—A small amount of bullion was produced in large part by amalgamation from dry gold ore mined in the Cracker Creek district. A few tons of ore was shipped to the Sumpter Valley smelter.

Greenhorn district.—The Bonanza, Golden Fleece, Psyche, and Lampwright properties were operated in a small way, and most of the ore was sent to the Sumpter Valley smelter, though the mill at the Bonanza mine was run part time. Several placers were productive in 1923. The greater part of the output came from properties equipped for hydraulic mining.

Home district.—A little bullion was recovered from the McLeish property, which was under development till late in the fall.

Homestead district.—The Homestead-Iron Dyke properties produced steadily throughout the year and were the largest producing deep mines in the State. The flotation mill treated considerably more ore than in 1922, and crude ore was also shipped to smelters. At the property of the Copper Trust Syndicate development was continued, and it is reported that an ore body carrying 10 per cent of copper, 4 per cent of lead, and 4 ounces of silver to the ton was opened.

Keating district (Eagle Creek).—The Copper Queen and Poorman properties were reopened with a view to supplying the Sumpter Valley smelter with fluxing ore. Several hundred tons of pyritic dry gold ore was shipped as test lots to the smelter, and gold, silver, and copper were recovered.

Rye Valley district.—The Cartwright, Spring Gulch, and Black Rock hydraulic mines, near Rye Valley, were productive in 1923. Apparently no quartz mines in this vicinity were in operation.

Snake River placers.—A few ounces of gold was recovered from hand washing of sand along Snake River, principally in the vicinity of Home.

Sparta district.—Bullion was produced at the Macy group of mines and the Town Lot pocket.

Stice district (Burnt River).—The Superior Dredging Co., of Salt Lake City, was engaged in the construction of a new 6,000 cubic yard dredge to replace the old dredge formerly on its properties near Bridgeport. The company owns 1,200 acres of land. It is stated[3] that drilling indicates the gravel to be from 17 to 40 feet deep and to average $1 a yard. In the vicinity of Hereford the Tom-Tom, Cow Creek, Patterson, and Yellow Metal placers were active and made a considerable recovery of gold from hydraulic operations.

Sumpter district.—A few tons of ore was mined at the Gold Bug property, near Sumpter, but the bulk of the production from this district was recovered from placers. The largest producer was the Powder River dredge, but some placer gold was recovered at hydraulic mines, notably the Buck Gulch, 6 miles west of Sumpter. The old Sumpter Valley dredge was sold for taxes in December.

Virtue district.—A little bullion was shipped as a result of development work on the Flagstaff mine, but apparently the Virtue mines were not operated.

[3] Salt Lake Min. Rev., Sept. 30, 1923, p. 11; Dec. 15, 1923, p. 14.

Weatherby district.—The Dixie mine, operated by Rizor & Lovejoy, produced bullion by amalgamation from dry gold ores. The Chicken Creek drift mine was also a producer.

COOS AND CURRY COUNTIES

A small quantity of siliceous gold ore from a prospect near Myrtle Point, Coos County, was shipped during the year. At the Robert E. gold mine, in the Chetco district, a mill was installed and further development completed, and the mine is expected to produce in 1924. Fourteen beach miners in the vicinity of Bullards, Powers, Sixes, Port Orford, and Wedderburn recovered 87.22 ounces of gold, 8 ounces of silver, and 24 ounces of crude platinum. One of the largest operations was that of the Inman Mines Co., which worked with seven giants. The Metals Producing Co. expects to hydraulic an old beach deposit on Cut Creek, 6 miles north of Bandon, during 1924, as prospecting and development work were completed during 1923.

DOUGLAS COUNTY

There was no production from quartz mines in Douglas County in 1923, though some properties near Riddle were under development. Six placer mines were operated, one of the largest of which was the Last Chance placer, on Azalea River, near Riddle. Some gold was saved from mines near Carson, Glendale, and Perdue.

GRANT COUNTY

In Grant County 16 deep mines were in operation in 1923, as compared with 9 in 1922, but the ore produced was 397 tons less than in the preceding year. The ore produced from deep mines in 1923 had an average value of $23.46 a ton. Ore sent to the amalgamation mills amounted to 157 tons and averaged $18.23 a ton in gold and silver, and 800 tons of ore was concentrated to 100 tons, which yielded $68.20 a ton at the smelter.

Cable Cove district.—The Mormon Boy mine, operated by lessees, shipped dry gold ore to the Sumpter Valley smelter.

Canyon City district.—The Empire gold dredge was one of the largest producers of gold bullion in Oregon during 1923. The Caledonia hydraulic mine and several small placers contributed to the output of the district. The Last Chance quartz property and the Jupiter hydraulic mine were developed and were expected to be on a producing basis early in 1924.

Granite district.—Siliceous gold ore was produced by the Buffalo-Monitor, Continental, Independence (old United Gold), La Belleview, Magnolia, and Red Boy mines, and most of it was shipped to the Sumpter Valley smelter. At the Independence all ore was treated in the new 50-ton flotation mill. The mine was closed during a large part of the year, pending reorganization of the operating company. The Ben Harrison mine remained closed, but development was under way at the Big Elk quartz mine. There were seven small placer operations in the district.

Greenhorn district.—Six miles of road was built to the Tempest mine, from which dry gold and silver ore was shipped to the Sumpter Valley smelter. Some bullion was recovered at the Morning and Gilbert quartz mines. The Denver Boy and Rabbit placers were operated and produced some gold.

Prairie City district.—The Standard Mining Co. shipped a few tons of dry gold ore to Sumpter from the Comer mine. The Cougar and Golden Eagle mines were also operated, and a small amount of placer gold was saved from deposits near Prairie City. The Gravel Top hydraulic mine, 2 miles north of the town, was equipped for work.

Susanville district.—The Rex Mining Co. prospected the Monitor and Rex mines, 20 miles northeast of Susanville, and shipped ore carrying gold, silver, and a little copper. Some ore was also shipped from dumps in the same vicinity.

JACKSON COUNTY

In Jackson County 718 tons of siliceous gold ore, having an average value in gold and silver of $9.62, was produced in 1923. There were 28 placer operations in the county in 1923, as compared with 20 in 1922, but the placer production was small on account of scarcity of water in the working season. The total production of the placer mines in the county was 672.70 ounces of gold and 94 ounces of silver, of which 89 per cent came from hydraulic mines and the rest from sluicing.

Applegate district.—Dry gold ore was milled at the new 4-stamp plant on the Great I Am mine, and a little bullion was also recovered at the Glory Hole mine. The Layton hydraulic mine was the largest producer in the district. Water was sufficient for the operation of two giants from January to June, and work began again in November.

Ashland district.—The Barron mine was under development, a 10-stamp mill was installed, and some ore was milled. At the Skyline a small amount of ore produced in the course of development work was milled.

Gold Hill district.—No bullion was shipped from deep mines in the Gold Hill district in 1923, but development was under way at the Gold Ridge, Millionaire, Blossom, and Sylvanite mines. Some gold was recovered as a by-product of the gravel operations of the Ancient River Gold Mining Co. This companay operated two dragline scrapers on an elevated river channel, primarily to supply gravel for road work and railroad ballast.

Jacksonville district.—The Gold Canyon Mining Co. took over the old Ivanhoe mine, installed a 5-stamp mill, and produced some bullion. The Highway Mining Co. operated the Third Alarm mine but produced no bullion. The Opp mine was inactive. Several small hydraulic operations contributed to the output of the district.

Jump Off Joe district.—A little hydraulic work was done at the head of Jump Off Joe Creek, but water was not plentiful.

Upper Applegate district.—There was sufficient water for the Sterling mine to operate its giants from March to July, and a good clean-up was made.

JOSEPHINE COUNTY

The 37 properties in Josephine County produced gold and silver having a total value of less than half that of the output in 1922. All the ore mined in 1923 at the quartz properties was siliceous gold ore carrying some silver. Of this ore 101 tons was treated by amalgamation mills at the mines and the rest was smelted. Some tailings were cyanided. The ore treated by amalgamation had an average value of $10.37 a ton, and the ore sent direct to the smelter over $50 a ton.

There were 33 placer operations in Josephine County, of which 25 were hydraulic mines, 7 sluice mines, and 1 drift mine. The hydraulic mines produced 69 per cent of the total placer output of the county, which was 609.91 ounces of gold and 88 ounces of silver. Placer mining was greatly restricted, owing to extremely low water. Most of the hydraulic mines were operated for only a few weeks.

Althouse district.—The Diamond Queen, Johnson & Ramsey, and Lucky H placers were the largest producers in the Althouse district.

Galice district.—The Sugar Pine quartz mine was operated under lease and produced some bullion. The California mine, on Mount Reuben, was further developed, and the Western Metal Mines Co. continued developing the Victor group and Independent, where a 3-stamp mill was installed. The Antler worked two giants while water lasted. The Dean & Dean hydraulic mine had water for only 10 days. Several other placers were productive in a small way.

Graves Creek district.—The High Tariff quartz mine produced some ore, and the Browning hydraulic mine had water for a 10-day run.

Holland district.—At the Boswell mine bullion was recovered in the treatment of old tailings at the cyanide plant. The Siskron or January First mine was taken over by San Francisco interests, and much development work done. A little bullion was produced in the mill late in the year, and it is said that the mill is to be enlarged.

Kerby district.—The Anderson hydraulic property had water for only a month's run. A few small placer operations made a little gold output.

Lower Applegate district.—The Oscar Creek hydraulic was apparently the only placer in the Lower Applegate district with sufficient water to operate.

Waldo district.—The Osgood hydraulic mine had water for a six months' run and recovered considerable bullion. Sampling operations at the Logan hydraulic mine resulted in the saving of some bullion.

Wolf Creek district.—The Blue Channel hydraulic was practically the only mine in the Wolf Creek district that was worked in 1923.

MALHEUR COUNTY

There were 3 deep mines and 8 placer mines in operation in the Mormon Basin and Rye Valley districts, and a small amount of gold was recovered from Snake River near Ontario. Of the total value of the gold and silver produced in Malheur County the deep mines contributed nearly one-half.

Mormon Basin district.—The Rainbow and Red, White, and Blue mines were inactive during 1923. At the Sunday Hill mine dry gold ore was produced and milled at the new plant, which was electrically equipped during the year. The placer gold recovered in the Mormon Basin district was largely won by hydraulicking, and the operations at the Jed Blair property were among the largest.

OTHER COUNTIES

A few tons of dry gold ore was shipped to a smelter in 1923 from a mine near Prineville, Crook County, which has since been closed. Some prospecting was done in the vicinity of Burns, Harney County, but no bullion or ore was shipped from this county in 1923. On practically none of the mines in the Bohemia district, Lane County, was more than assessment work done, though a small lot of bullion was shipped from the Evening Star mine through the Bank of Cottage Grove. Some development work was done on the Crown, Mayflower, and Silver King mines, in the Santien district, Marion County, but no ore was milled or shipped. In Wheeler County a little bullion was saved by hydraulic operations in the Spanish Gulch district.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN IDAHO

(MINE REPORT)

By C. N. Gerry[1]

PRODUCTION

SUMMARY

The value of the mine production of gold, silver, copper, lead, and zinc in Idaho in 1923 was 47 per cent greater than in 1922, as a result of better market conditions and the resumption of mining by several of the large producing mines. Though the value of the metal produced was greatly increased, it did not reach the average annual value for the last decade, which was nearly $31,000,000. Dividends for 1923, partly estimated, amounted to $4,944,000.

Mine production of gold, silver, copper, lead, and zinc in Idaho in 1923

	Number of producers	Ore	Gold [a]	Silver [a]	Copper	Lead	Recoverable zinc	Total value
		Short tons		*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
1923	231	1,763,520	$767,427	7,673,662	3,979,631	242,355,733	27,952,749	$26,510,524
Increase or decrease from 1922	−17	+326,636	+266,022	+1,591,797	+696,789	+46,521,528	+23,843,618	+8,478,969
Total, 1863–1923	------	----------	134,627,176	266,620,200	137,510,644	7,134,655,176	462,402,250	763,948,752

[a] Includes placer production.

Tables printed in the report for 1922 give the source of the different metals by kinds of ore and by years from 1911 to 1922. During that period the gold was derived largely from dry and siliceous ore and from placers. About 80 per cent of both the silver and lead came from lead ore, and most of the remainder from lead-zinc ore and zinc ore.

ORE

The increase in the quantity of ore sold or treated in Idaho in 1923 was 23 per cent. Of the total output nearly 68 per cent was lead ore; siliceous ore represented 1 per cent; copper ore, 2 per cent;

[1] Much work in the preparation of this report, especially in the compilation of tables, was done by B. N. Lowry, of the United States Geological Survey.

copper-lead ore, nearly 3 per cent; and lead-zinc ore, nearly 26 per cent. These ores had the following value: Dry gold ore, $131,039; dry gold and silver ore, $3,037; dry silver ore, $59,816; copper ore, $503,215; lead ore, $18,049,510; copper-lead ore, $967,656; and lead-zinc ore, $6,292,117. Most of the dry and siliceous ore was treated by amalgamation. The first-class shipping ore—99,626 tons—was largely lead ore and copper ore, and the average content of the crude shipping product is given on page 383.

Most of the copper ore, lead ore, copper-lead ore, and lead-zinc ore was milled; the results are stated in the table on concentrates (p. 382).

Ore and metals produced in Idaho in 1923

Source	Number of producers	Ore		Gold		Silver	
		Short tons	Per cent	Fine ounces	Per cent	Fine ounces	Per cent
Dry gold ore	47	21,953	1.24	6,247.99	16.83	2,288	0.03
Dry gold and silver ore	6	311	.02	82.91	.22	1,613	.02
Dry silver ore	14	1,795	.10	239.24	.64	63,393	.82
Copper ore	11	41,901	2.37	1,516.80	4.09	74,247	.97
Lead ore	67	1,192,442	67.62	2,066.00	5.57	5,489,477	71.54
Copper-lead ore	4	52,291	2.97	2,587.09	6.97	917,215	11.95
Lead-zinc ore	5	452,827	25.68	259.20	.70	1,118,813	14.58
Total deep mines		1,763,520	100.00	12,999.23	35.02	7,667,046	99.91
Total placers	85			24,125.05	64.98	6,616	.09
		1,763,520		37,124.28	100.00	7,673,662	100.00
Increase from 1922		326,636		12,868.82		1,591,797	

Source	Copper		Lead		Zinc	
	Pounds	Per cent	Pounds	Per cent	Pounds	Per cent
Dry gold ore	41					
Dry gold and silver ore						
Dry silver ore	5,494	0.14	29,719	0.01		
Copper ore	2,794,091	70.21	3,517			
Lead ore	594,748	14.94	191,685,757	79.10		
Copper-lead ore	546,343	13.73	1,167,818	.48		
Lead-zinc ore	38,914	.98	49,468,922	20.41	27,952,749	100.00
	3,979,631	100.00	242,355,733	100.00	27,952,749	100.00
Increase from 1922	696,789		46,521,528		23,843,618	

GOLD ORE

Most of the gold ore was produced from the Gold Hill & Iowa property, in Boise County; and other producers were the Merry Blue mine, in Valley County; the Unity mine, at Warren, Idaho County; and the Ulysses mine, in Lemhi County. In past years the mines of Elmore, Idaho, and Lemhi counties produced much gold ore, but in 1923 the output was small on account of transportation and metallurgic difficulties. The gold ore averaged $5.88 in gold and 0.10 ounce of silver to the ton.

Content of dry gold ore sold or treated in Idaho in 1923

County	Ore	Gold	Silver	Copper
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*
Ada	13	18.47	11	
Blaine	23	28.20	8	
Boise	18,896	3,912.56	818	
Bonner	7	10.65	2	
Camas	10	20.11	12	
Custer	1	.42		
Elmore	429	221.94	131	
Idaho	621	752.49	510	
Lemhi	802	423.04	253	
Owyhee	22	47.06	177	41
Shoshone	115	80.35	32	
Valley	1,002	725.37	333	
Washington	12	7.33	1	
	21,953	6,247.99	2,288	41

GOLD AND SILVER ORE

The Neversweat mine and other property in Owyhee County produced gold and silver ore, most of which was concentrated. The ore averaged $5.51 in gold and 5.19 ounces of silver to the ton.

SILVER ORE

Silver ore was produced principally in Owyhee and Shoshone counties, mainly by the Flint mine, south of Silver City, and the Argentine and Big Creek mines, near Osborne and Kellogg. Bonner County produced ore that is usually referred to as silver ore, as it is valuable principally for silver, but it contained enough of the base metals to be classified as copper-lead ore. The silver ore of the State as a whole averaged $2.75 in gold and 35.32 ounces of silver to the ton, as well as a small quantity of copper and lead.

Content of dry silver ore sold or treated in Idaho in 1923

County	Ore	Gold	Silver	Copper	Lead
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Bonner	30	2.68	4,128	695	927
Custer	5	31.00	2,420	384	534
Gem	21	18.64	2,134	68	549
Lemhi	1		71		17
Owyhee	825	185.00	30,916	239	77
Shoshone	891	1.92	22,765	3,251	27,615
Washington	22		959	857	
	1,795	239.24	63,393	5,494	29,719

COPPER ORE

Copper ore was mined principally in Lemhi and Custer counties. The Idaho Metals Co., at Mackay, and the Pope Shenon and Harmony mines, near Salmon, were large producers. Only small lots were shipped from the St. Joe district, Shoshone County. The ore averaged $0.75 in gold and 1.77 ounces of silver to the ton and contained 3.33 per cent of copper.

Content of copper ore sold or treated in Idaho in 1923

County	Ore	Gold	Silver	Copper	Lead
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Adams	308	0.09	1,926	5,110	1,241
Bonner	61	12.00	19,433	9,079	161
Clark	38	2.23	50	20,207	----------
Custer	15,835	1,458.00	50,006	1,458,549	2,115
Lemhi	25,594	34.34	2,784	1,280,040	----------
Shoshone	65	10.14	48	21,106	----------
	41,901	1,516.80	74,247	2,794,091	3,517

LEAD ORE

The lead ore, the most valuable source of metal in Idaho, mined in 1923 consisted largely of milling ore from Shoshone County. Lead ore in quantity was also mined and shipped from Boundary, Blaine, Lemhi, and Custer counties. The Bunker Hill & Sullivan property, in Shoshone County, was the leading producer, and the Continental mine, in Boundary County, led the mines in the other counties. The average content of all lead ores was 4.60 ounces of silver to the ton, 0.02 per cent of copper, and 8.04 per cent of lead.

Content of lead ore sold or treated in Idaho in 1923

County	Ore	Gold	Silver	Copper	Lead
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Blaine	26,518	458.99	248,299	16,864	1,881,026
Boise	684	166.91	2,068	1,502	45,837
Bonner	117	.02	1,783	939	110,669
Boundary	60,030	----------	96,258	----------	4,233,206
Custer	6,977	53.85	45,141	5,140	1,099,731
Lemhi	17,003	340.08	122,556	34,019	4,959,287
Shoshone	1,081,113	1,046.15	4,973,372	536,284	179,356,001
	1,192,442	2,066.00	5,489,477	594,748	191,685,757

COPPER-LEAD ORE

Nearly all the copper-lead ore mined in 1923, which came largely from the Ramshorn mine, in Custer County, and the Talache mine, in Bonner County, was of milling grade and contained considerable gold and silver. It averaged $1.02 in gold and 17.54 ounces of silver to the ton, 0.52 per cent of copper, and 1.12 per cent of lead.

Content of copper-lead ore sold or treated in Idaho in 1923

County	Ore	Gold	Silver	Copper	Lead
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Bonner	47,053	2,578.70	646,850	436,849	517,245
Custer	5,238	8.39	270,365	109,494	650,573
	52,291	2,587.09	917,215	546,343	1,167,818

ZINC ORE AND LEAD-ZINC ORE

No zinc ore was sold in 1923, but the output of lead-zinc ore was large. Five mines in Shoshone County produced all the lead-zinc ore, most of which was concentrated. It averaged 2.47 ounces of silver to the ton, 5.46 per cent of lead, and 3.09 per cent of zinc.

GOLD

The mine production of gold in Idaho in 1923 showed an increase of 53 per cent and nearly reached the yearly output of the last decade, which was about $800,000. The gold output from Idaho was steadily decreasing prior to 1920, but dredges in Elmore and Shoshone counties are now bringing the output up to old levels, notwithstanding the fact that gold from lode mines is less. The deep mines produced $268,718 in gold, and the placers $498,709, of which $469,900 was won by dredges. Gold from copper-lead ore increased slightly, but that from siliceous ore, copper ore, and lead ore was less. The production of gold from mills using amalgamation and cyanidation decreased to 5,987.70 ounces, which was more than 16 per cent of the total. Concentrates of all kinds contained 12 per cent of the total gold, and crude ore shipped to smelters contained nearly 7 per cent of the total. Since 1897 a total of $5,068,287 in gold has been recovered by dredges.

In 1923 only five mines had a gold output of more than $25,000 each—those of the Yukon Gold Co., at Murray; the South Park Dredging Co., at Featherville; the Gold Hill & Iowa Mines Co., at Quartzburg; the Talache Mines Co., in Bonner County; and the Idaho Metals Co., at Mackay.

SILVER

The mine production of silver in Idaho in 1923 was 26 per cent greater than in 1922 but was still decidedly less than the yearly average of the last decade. Outside of Shoshone County, which produced 80 per cent of the silver and had a large increase, the main increase was in Bonner County. Silver from Blaine County decreased to a marked degree.

Concentrates contained nearly 78 per cent of the silver, shipping ore 22 per cent, and placer bullion and gold and silver bullion from deep mines less than 1 per cent.

Nine mines—the Bunker Hill & Sullivan, Morning, Hercules, Hecla, Talache, Tamarack & Custer, Ramshorn, Independence, and Gold Hunter—produced more than 200,000 ounces of silver each.

COPPER

The mine production of copper in Idaho increased about 21 per cent in 1923. The average yearly output for the last decade was about 5,000,000 pounds, but during the last five years it has been less than 3,000,000 pounds. The largest increases were in Lemhi, Shoshone, and Bonner counties. Much copper ore was shipped from mines near Salmon, but only a little ore was shipped from copper

mines in Shoshone County. The largest producers of copper in the State were the Idaho Metals Co., at Mackay; the Pope Shenon and Harmony mines, near Salmon; and the Talache mine, in Bonner County. Crude shipping ore of all kinds contained 42 per cent of the copper, and concentrates 58 per cent.

LEAD

The mine production of lead in Idaho in 1923 increased about 24 per cent in quantity and nearly 58 per cent in value. The average price of lead increased from 5.5 cents a pound in 1922 to 7 cents in 1923. Shoshone County supplied more than 94 per cent of the total output, but a good production was made in Lemhi and Boundary counties. Concentrates of all kinds yielded 82 per cent of the total, and crude ore shipped was the source of 18 per cent.

Fourteen mines produced more than 1,000,000 pounds of lead each in 1923. Three of them—the Bunker Hill, Morning, and Hercules—produced more than 30,000,000 pounds each; the other large producers were the Hecla, Tamarack & Custer, Callahan, Success, Idaho Continental, Pittsburg-Idaho, Gold Hunter, Independence, Latest Out, Mace, and Sierra Nevada.

ZINC

The recoverable zinc in the ore mined amounted to 27,952,749 pounds, a large increase from 4,109,131 pounds in 1922, when most of the zinc mines were idle. As the average price of zinc increased to 6.8 cents a pound and there was a demand for zinc material at the Anaconda plant at Great Falls, Mont., the Callahan, Morning, and Success mines were actively marketing zinc concentrate. The Callahan property, the largest producer, was idle the last quarter of the year but shipped much zinc concentrate to eastern smelters during the first nine months.

MINING INDUSTRY

The mines of Idaho, particularly those of the Coeur d'Alene region, were not slow to take advantage of the improvement in the lead market in 1923. Wages of miners were increased in March, the price of lead rose to more than 8 cents a pound, the regular producing mines were active, and dividends of nearly $1,000,000 were paid in the first quarter. Conditions were nearly ideal for an unusually large production. Later, however, the price of lead decreased slightly, the price of silver dropped from $1 to about 64 cents an ounce, and a disastrous fire closed the Hecla mine, one of the largest producers of silver-lead ore. Despite these adverse circumstances and the fact that the Callahan Zinc-Lead mine was closed in October, the metal output of Idaho in 1923 approached the average yearly output of the last decade. A good market for zinc ore stimulated mining in the Pine Creek region, southwest of Kellogg, and the activity of two large dredges materially increased the production of gold.

METALLURGIC INDUSTRY

In Idaho 48 milling plants of all kinds were in operation in 1923, against 45 in 1922. Of these mills 27 were concentration plants, 15 of which used flotation machines with other concentrating devices, 3 used flotation alone, and 9 used crushers, jigs, and tables without flotation cells; 18 used amalgamation alone; 1 used cyanidation; and 2 used amalgamation, concentration, and cyanidation. Other mills were in course of construction or removal from one property to another.

Only about 1 per cent of the ore was treated in gold and silver mills in 1923. Bullion from this ore treated by amalgamation and cyanidation was valued at $125,271, or $5.72 a ton of ore, and showed a decrease in total quantity and in average value. Most of the gold in bullion was won by amalgamation, and 250 pounds of quicksilver and 3,900 pounds of sodium cyanide were used at these mills in 1923. The average quicksilver purchased was 0.012 pound per ton of ore amalgamated and 0.035 pound per ounce of gold and silver bullion saved. The consumption of cyanide was 5.30 pounds per ounce of gold and silver bullion recovered.

Gold and silver produced in mills in Idaho in 1923, by counties

County	Ore (short tons)	Bullion (fine ounces) recovered from ore by				Total value
		Amalgamation		Cyanidation		
		Gold	Silver	Gold	Silver	
Ada	13	18.47	11			$391
Blaine	23	28.20	8			590
Boise	[a] 18,896	3,599.84	576	203.51	85	79,164
Bonner	7	10.65	2			222
Camas	2	2.11	2			46
Custer	3	.42		.94	22	46
Elmore	425	120.68	82	98.73	43	4,638
Idaho	621	752.49	510			15,973
Lemhi	765	70.30	11	244.25	39	6,543
Owyhee	17	24.06	65			550
Shoshone	115	80.35	32			1,687
Valley	1,002	725.37	333			15,268
Washington	12	7.33	1			153
	21,901	5,440.27	1,633	547.43	189	125,271

[a] Also yielded 31 tons of concentrate.

Of the total ore 89 per cent was concentrated. Concentrates from this ore, from 68,982 tons of old tailings treated, and from ore treated in gold and silver mills were valued at $79.77 a ton, against $69.16 in 1922. The concentrates came largely from the Coeur d'Alene region, and the ratio was 5.90 tons of ore and tailings to 1 ton of concentrate. Most of the total was lead concentrate, in which there was a large increase, but zinc concentrate and lead-zinc concentrate also increased considerably. Operators in Shoshone County shipped an average of 20,634 tons of concentrates of various kinds a month, against 14,974 tons in 1922. This with the crude ore shipped, which was 5,923 tons a month, gives the Coeur d'Alene region an average monthly output of 26,557 tons of concentrates and crude ore, against 20,179 tons in 1922. The average metal

content of the lead concentrate was about the same as that of 1922, but the average value increased from $68 to $80.15 a ton. The copper-lead concentrate was valuable principally for the silver it contained.

Mine production of metals from Idaho concentrates in 1923

By counties

County	Ore to concentrating mills	Concentrates	Gold	Silver	Copper	Lead	Recoverable zinc	Total value of concentrates
	Short tons	*Short tons*	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
Adams	300	49		1,899	2,561	1,241		$2,021
Blaine	25,834	3,106	403.48	192,439	11,713	1,395,889		265,575
Boise	684	176	276.12	2,225	1,502	45,837		10,962
Bonner	47,059	4,431	2,578.72	646,858	436,910	517,465		684,179
Boundary	59,947	3,434		94,382		4,148,482		367,787
Custer	9,227	1,132	11.97	252,816	90,574	739,201		272,614
Elmore	3	1	1.00	1				22
Lemhi	34,060	3,770	71.02	22,868	1,258,629	768,398		259,026
Owyhee	1,055	84	85.00	4,757	41			5,664
Shoshone	1,394,842	247,602	1,029.40	4,745,497	509,355	190,076,885	27,666,861	19,174,191
	1,573,011	263,785	4,456.71	5,963,742	2,311,285	197,693,398	27,666.861	21,042,041

By kinds of concentrates

Dry and siliceous		160	195.60	5,366	352			$8,496
Copper		2,885	32.76	4,249	1,257,580	1,241		189,112
Lead		221,670	1,602.09	4,961,849	524,156	194,118,968		17,767.213
Zinc		22,508		32,200		1,400,000	19,726,654	1,465,817
Copper-lead		5,128	2,585.06	886,206	525,793	955,586		924,310
Lead-zinc		11,434	41.20	73,872	3,404	1,217,603	7,940,207	687,093

Average content

Kind of concentrates	Concentrates	Gold	Silver	Copper	Lead	Recoverable zinc	Total value
	Short tons	*Fine ounces per ton*	*Fine ounces per ton*	*Per cent*	*Per cent*	*Per cent*	
Dry and siliceous	160	1.22	33.54	0.11			$53.10
Copper	2,885	.01	1.47	21.80			65.55
Lead	221,670	.01	22.38	.12	41.78		80.15
Zinc	22,508		1.43		3.11	43.82	65.12
Copper-lead	5,128	.50	172.82	5.13	9.32		180.25
Lead-zinc	11,434		6.46	.01	5.32	34.72	60.09
	263,785	.01	22.61	.876	37.47	5.24	79.77

Of the total ore nearly 6 per cent was shipped crude to smelters, and most of it with the concentrates was treated at Bradley, Idaho; East Helena and Great Falls, Mont.; Vallejo, Calif.; and near Salt Lake City, Utah. The total value of the first-class ore was $4,816,065, against $4,239,673 in 1922. Of the crude ore shipped 82 per cent was lead ore, and the remainder largely copper ore. Most of the ore smelted was sulphide, though about one-fourth of the lead ore was carbonate. The combined value of the concentrates and crude shipping ore was $25,858,106.

Mine production of metals from Idaho crude ore shipped to smelters in 1923

By counties

County	Ore	Gold	Silver	Copper	Lead	Recoverable zinc	Total value
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
Adams	8	0.09	27	2,549			$399
Blaine	684	55.51	55,860	5,151	485,137		81,669
Bonner	202	14.68	25,336	10,652	111,537		30,452
Boundary	83		1,876		84,724		7,469
Camas	8	18.00	10				380
Clark	38	2.23	50	20,207			3,057
Custer	18,828	1,539.27	115,116	1,482,993	1,013,752		415,178
Elmore	1	1.53	5				36
Gem	21	18.64	2,134	68	549		2,183
Lemhi	8,575	411.89	102,746	55,430	4,190,906		394,278
Owyhee	84	205.00	27,862	239	77		27,125
Shoshone	71,072	287.98	1,361,520	90,200	38,540,382	285,888	3,852,927
Washington	22		959	857			912
	99,626	2,554.82	1,693,501	1,668,346	44,427,064	285,888	4,816,065

By kinds of ore

Dry and siliceous	804	386.87	60,106	5,183	29,719		$60,126
Copper	16,088	1,484.04	69,998	1,536,511	2,276		314,102
Lead	82,127	664.90	1,530,978	106,102	44,144,058		4,374,828
Copper-lead	220	2.01	31,009	20,550	212,232		43,347
Lead-zinc	387	17.00	1,410		38,779	285,888	23,662

Average content

Kind of ore	Ore	Gold	Silver	Copper	Lead	Recoverable zinc	Total value
	Short tons	*Fine ounces per ton*	*Fine ounces per ton*	*Per cent*	*Per cent*	*Per cent*	
Dry and siliceous	804	0.48	74.76	0.32	1.85		$74.78
Copper:							
Oxidized	854	.09	30.35	7.00	.12		47.62
Sulphide	15,234	.09	2.89	4.65			17.95
Lead:							
Oxidized	18,253	.02	14.91	.10	17.46		37.37
Sulphide	63,874		19.71		29.57		57.81
Copper-lead:							
Oxidized	1	.01	405.00	15.10	8.90		389.00
Sulphide	219		139.74	4.62	48.41		196.15
Lead-zinc: Sulphide	387	.04	3.64		5.00	3.69	61.14
	99,626	.03	17.00	.84	22.30	.14	48.34

PRODUCTION BY COUNTIES

GENERAL FEATURES

Mine production of gold, silver, copper, lead, and zinc in Idaho in 1923

County	Gold					Silver	
	Placers		Deep mines		Total value	Fine ounces	Value
	Fine ounces	Value	Fine ounces	Value			
Ada	13.93	$288	18.48	$382	$670	14	$11
Adams			.10	2	2	1,926	1,579
Bingham	9.10	188			188		
Blaine			487.19	10,071	10,071	248,307	203,612
Boise	503.01	10,398	4,079.46	84,330	94,728	3,025	2,481
Bonner			2,604.07	53,831	53,831	672,196	551,201
Bonneville	39.52	817			817	2	2
Boundary						96,258	78,932
Camas			20.13	416	416	12	10
Canyon	2.56	53			53		
Clark			2.23	46	46	50	41
Clearwater	295.96	6,118			6,118	71	58
Custer	54.85	1,134	1,552.60	32,095	33,229	367,977	301,741
Elmore	10,719.56	221,593	221.94	4,588	226,181	3,807	3,122
Gem			18.62	385	385	2,134	1,750
Idaho	402.34	8,317	752.47	15,555	23,872	581	476
Latah	41.02	848			848	3	2
Lemhi	192.82	3,986	797.46	16,485	20,471	125,682	103,059
Owyhee			314.05	6,492	6,492	32,684	26,801
Shoshone	11,784.34	243,604	1,397.75	28,894	272,498	6,117,621	5,016,449
Twin Falls	7.84	162			162		
Valley	42.62	881	725.38	14,995	15,876	349	286
Washington	15.58	322	7.30	151	473	963	790
	24,125.05	498,709	12,999.23	268,718	767,427	7,673,662	6,292,403

County	Copper		Lead		Recoverable zinc		Total value
	Pounds	Value	Pounds	Value	Pounds	Value	
Ada							$681
Adams	5,110	$751	1,241	$87			2,419
Bingham							188
Blaine	16,864	2,479	1,881,026	131,672			347,834
Boise	1,502	221	45,837	3,209			100,639
Bonner	447,562	65,792	629,002	44,030			714,854
Bonneville							819
Boundary			4,233,206	296,324			375,256
Camas							426
Canyon							53
Clark	20,207	2,970					3,057
Clearwater							6,176
Custer	1,573,567	231,314	1,752,953	122,707			688,991
Elmore							229,303
Gem	68	10	549	38			2,183
Idaho							24,348
Latah							850
Lemhi	1,314,059	193,167	4,959,304	347,151			663,848
Owyhee	280	41	77	5			33,339
Shoshone	599,555	88,135	228,852,538	16,019,678	27,952,749	$1,900,787	23,297,547
Twin Falls							162
Valley							16,162
Washington	857	126					1,389
	3,979,631	585,006	242,355,733	16,964,901	27,952,749	1,900,787	26,510,524

Producing placer mines and production of placer gold and silver in Idaho in 1922 and 1923

County	1922						1923					
	Mines			Gold	Silver (fine ounces)	Total value	Mines			Gold	Silver (fine ounces)	Total valu
	Hydraulic	Dredge	Drift				Hydraulic	Dredge	Drift			
Ada	3	----	1	$330	3	$333	2	----	----	$288	3	$290
Bingham	1	----	----	28	----	28	2	----	----	188	----	188
Boise	13	----	2	8,393	97	8,490	14	----	----	10,398	139	10,512
Bonneville	1	----	----	97	----	97	4	----	----	817	2	819
Camas	1	----	----	155	2	157	----	----	----	----	----	----
Canyon	----	----	----	----	----	----	1	----	----	53	----	53
Clearwater	5	1	----	6,058	73	6,131	3	1	----	6,118	71	6,176
Custer	4	----	----	1,073	18	1,091	6	1	----	1,134	23	1,153
Elmore	2	1	----	30,912	517	31,429	5	1	----	221,593	3,676	224,608
Gem	1	----	----	175	4	179	----	----	----	----	----	----
Gooding	1	----	----	26	----	26	----	----	----	----	----	----
Idaho	24	----	----	7,512	62	7,574	22	----	----	8,317	71	8,375
Jerome	1	----	----	83	----	83	----	----	----	----	----	----
Kootenai	1	----	----	36	----	36	----	----	----	----	----	----
Latah	4	----	----	1,116	3	1,119	3	----	----	848	3	850
Lemhi	11	----	----	3,529	14	3,543	8	----	----	3,986	18	4,001
Owyhee	2	----	----	95	----	95	----	----	----	----	----	----
Power	1	----	----	155	----	155	----	----	----	----	----	----
Shoshone	2	1	2	122,999	1,160	124,159	4	1	----	243,604	2,591	245,729
Twin Falls	2	----	----	706	2	708	1	----	----	162	----	162
Valley	5	----	----	371	3	374	5	----	----	881	16	894
Washington	1	----	----	123	1	124	1	----	----	322	3	324
	86	3	5	183,972	1,959	185,931	81	4	----	498,709	6,616	504,134

Ore sold or treated, deep mines producing, and average value of ores in Idaho in 1922 and 1923, by counties

County	Ore sold or treated in 1923 (short tons)		Number of deep mines producing		Average total value per ton		Average value per ton in gold and silver	
	Total	Increase or decrease	1922	1923	1922	1923	1922	1923
Ada	13	−45	3	2	$16.78	$30.08	$16.33	$30.08
Adams	308	+263	1	2	31.91	7.85	----	5.13
Blaine	26,541	−18,989	24	15	14.97	13.11	10.52	8.05
Boise	19,580	−400	12	10	7.38	4.60	7.28	4.43
Bonner	47,268	+21,055	5	9	19.07	15.12	16.66	12.80
Boundary	60,030	+24,439	1	2	6.15	6.25	1.69	1.31
Butte	----	−67	4	----	68.34	----	35.04	----
Camas	10	−368	3	2	20.95	42.60	19.10	42.60
Clark	38	+18	2	1	38.10	80.45	5.30	2.29
Custer	28,058	+465	13	15	26.16	24.51	13.01	11.90
Elmore	429	+395	2	8	18.21	10.94	18.21	10.94
Gem	21	−13	2	2	28.76	103.95	27.62	101.67
Idaho	621	+134	9	8	28.59	25.72	28.59	25.72
Lemhi	43,400	+14,965	22	17	16.04	15.20	4.04	2.75
Owyhee	1,156	−338	11	11	19.34	28.84	19.31	28.80
Shoshone	1,535,011	+285,475	36	38	12.02	15.02	3.77	3.29
Valley	1,002	+282	1	2	25.61	15.24	25.61	15.24
Washington	34	−635	3	2	26.60	31.32	24.54	27.62
	1,763,520	+326,636	154	146	12.42	14.75	1.45	3.72

ADA COUNTY

Black Hornet district.—The output of the Black Hornet district consisted of several small lots of gold bullion from the Maynard and Gold Bond properties.

Highland district.—A little placer gold was mined from the Charcoal and other claims near Barber.

ADAMS COUNTY

Seven Devils district.—Copper ore was mined from the Azurite and River Queen mines, near Homestead, Oreg. Several hundred tons of ore was milled by the Azurite Mining Co., which has a 50-ton concentration plant equipped with Zeigler flotation machines. The mine is said to have in reserve 50,000 tons of ore which contains an average of 12 ounces of silver to the ton and 10 per cent of zinc, as well as some copper and lead. An article describing the conditions at the Red Ledge property,[2] a low-grade copper prospect 15 miles northwest of Cuprum, was published in June. A large quantity of copper ore has been indicated by 10,000 feet of diamond drill work, but equipping the property for production would be extremely expensive on account of its isolation and the ruggedness of the country.

BINGHAM COUNTY

A little placer gold was mined from Snake River near Aberdeen.

BLAINE COUNTY

Mine production of gold, silver, copper, lead, and zinc in Blaine County, Idaho, in 1923

	Number of producers	Ore	Gold	Silver	Copper	Lead	Recoverable zinc	Total value
		Short tons		*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
1923	15	26,541	$10,071	248,307	16,864	1,881,026	----------	$347,834
Decrease from 1922	9	18,989	7,573	213,177	10,688	1,714,493	18,121	333,801
Total, 1880–1923	------	--------	2,556,593	17,662,835	362,245	198,571,142	8,015,211	28,262,357

From 1880 to 1923 Blaine County has produced $2,556,593 in gold, $16,180,620 in silver, $63,627 in copper, $8,811,935 in lead, and $649,582 in zinc. Though the value of the output decreased in 1923, much development work was done in prospecting some of the old mines of the Mineral Hill and Warm Springs districts.

Mineral Hill district (Hailey).—Nine deep mines in the Mineral Hill district produced 55 tons of ore, containing $561 in gold, 2,563 ounces of silver, 130 pounds of copper, and 30,226 pounds of lead, valued in all at $4,798, or $87.24 a ton. The output, the value of which decreased from $16,300 in 1922, consisted of small lots of

[2] Red Ledge Idaho's hope: Min. Truth, June 16, 1923.

ore shipped from the Eureka, Hope, La Grande, Minnie Moore, Parnell, Silver King, Queen of the Hills, and Compensation properties and was largely sulphide lead ore. The Federal Mining & Smelting Co. spent much money sinking the Allen shaft preparatory to opening the old Minnie Moore mine, a large producer of silver-lead ore in the eighties, but no new ore was discovered during 1923. Continuous exploration work amounting to 4,000 feet was done by the Bunker Hill & Sullivan Mining & Concentrating Co. on the Bullion-Mayflower-Red Elephant group, but no commercial ore bodies were discovered.

Warm Springs district (*Ketchum*).—Six deep mines in the Warm Springs district produced 26,486 tons of ore, containing $9,510 in gold, 245,744 ounces of silver, 16,734 pounds of copper, and 1,850,800 pounds of lead, valued in all at $343,036, or $12.95 a ton. The output was divided into 25,834 tons of milling ore, 650 tons of crude silver-lead ore, and a small test lot of gold ore. The largest output came from the Independence mine, operated by the Federal Mining & Smelting Co. As the deposit is practically exhausted, the company ceased operations August 1, since when lessees have worked the property. Several thousand tons of concentrate and crude ore containing gold and silver, as well as lead, was shipped to the smelter at Murray, Utah. The mill is equipped with crushers, rolls, jigs, tables, ball mills, screens, classifiers, thickeners, and a filter press. From January to August the company did 5,842 feet of development work in drifts and raises. According to its annual report, 25,706 tons of lead ore was mined in 1923, most of which was milled. From 1917 to 1923 the Independence mine produced 146,642 tons of ore containing gold, silver, and lead. The Mineral Exploration Co. operated the Homestake mine and shipped several cars of oxidized lead ore. Small lots were shipped from the Mascot, Triumph, Woodrow Wilson, and Henrietta properties.

BOISE COUNTY

Mine production of gold, silver, copper, and lead in Boise County, Idaho, in 1923

	Number of producers	Ore	Gold [a]	Silver [a]	Copper	Lead	Total value
		Short tons		*Fine ounces*	*Pounds*	*Pounds*	
1923	24	19,580	$94,728	3,025	1,502	45,837	$100,639
Increase or decrease from 1922	−3	−400	−54,056	−2,128	+1,392	+7,872	−55,401
Total, 1863–1923			53,512,983	2,218,966	[b]	[b]	[b]

[a] Includes placer production.
[b] Figures not available.

The output of ore in Boise County in 1923 was about the same as that of 1922, but the value of the gold decreased $54,056, largely owing to a decreased output from deep mines.

Boise Basin district (*Placerville, Quartzburg, Idaho City*).—Nine deep mines and 14 placers in the Boise Basin district produced 19,578 tons of ore, $94,681 in gold, 3,021 ounces of silver, 1,502 pounds of copper, and 45,837 pounds of lead, valued in all at $100,589. The

ore had an average value of $4.60 a ton, and the placer output consisted of $10,398 in gold and 139 ounces of silver. The Gold Hill & Iowa mine was operated by Walker & Hawley and later by the El Cerro del Oro Co. under bond and lease. About 18,000 tons of ore was treated in a 150-ton mill by amalgamation, concentration, and cyanidation, but the output of gold was considerably less than formerly. The company has in reserve several thousand tons of ore averaging about $7 a ton, and 500 feet of drifting was done during 1923. Ores from the Golden Queen, Hay Fork, Independence, and Mammoth properties were treated by amalgamation. The Mineral Mining Co. treated several hundred tons of ore in a small concentration plant and shipped lead concentrate to smelters near Salt Lake City, Utah. The company did more than 1,000 feet of development work and reports 50,000 tons of ore in reserve. The Golden Age Junior Mining Co. was building a new 150-ton mill equipped for fine grinding and flotation, and the Idawa Gold Mining Co. continued to develop a low-grade gold deposit, for which the construction of a 100-ton mill was started. Active development work was done on the Washington Subrosa group by the Monetary Metals Co., which will soon be ready to produce ore. Most of the placer gold was mined from bench gravel between Elk and Moores creeks by the Boise Placer Co., which washed about 85,000 cubic yards of gravel. Placer gold was also mined at the Sniveley, Crevice Diggings, Gold Eagle, Lemon Grade, Last Chance, Swede Gulch, and Boston & Idaho properties. No dredges have been operated in the district since 1918, though a large output of gold was won by dredges from 1911 to 1916.

BONNER COUNTY

Lakeview district.—Test lots of ore were shipped by the Falls Creek Mining Co. and the Hewer Mining Co. The Hewer Co., in charge of the Venzwela group, did 900 feet of development work and made milling tests for concentration. It is estimated that the property has 100,000 tons of ore containing approximately 14 ounces of silver to the ton, for which a flotation mill will be installed. The silver occurs in pyrargyrite, tetrahedrite, and galena. Development work was done at the Conjecture property by the Lakeview Silver Mines Co., which has 30,000 tons of silver ore in reserve for future milling.

Pend d'Oreille district.—Six deep mines in the Pend d'Oreille district produced 47,224 tons of ore, containing $53,829 in gold, 671,416 ounces of silver, 446,623 pounds of copper, and 607,130 pounds of lead, valued in all at $712,543, or $15.09 a ton. Most of the ore was milled, and several thousand tons of copper-lead concentrate containing considerable silver was shipped to Montana and Washington for smelting. The Talache Mines (Inc.) operated a 150-ton concentration-flotation mill continuously except for a period of one-shift operation in November. The cessation of purchases under the Pittman Act necessitated the search for ore of higher grade, and partly with this object in view more than 6,000 feet of development work was done, which is said to have opened rich silver ore in the north drift on the No. 6 level. This property became a notable producer of silver ore in 1922 and now competes

with the large mines of the Coeur d'Alene region. The ore occurs as irregular lenses in a fissure vein, and the prominent valuable minerals are tetrahedrite, native silver, chalcopyrite, and galena. One lot of rich silver ore was shipped from the Blue Bird mine, and several lots of lead ore from the Mimetite, Lawrence, and Opportunity properties.

Priest Lake district.—The Rippeto lease, near Priest River, produced one lot of silver-lead ore, which was shipped to Utah for smelting.

BONNEVILLE COUNTY

Four placers in the Mount Pisgah district produced $817 in gold and 2 ounces of silver. The American placer and the Barnes group were the main producers.

BOUNDARY COUNTY

Moyie Yahk district.—The Eileen Mining Co., which owns a prospect near Meadow Creek, shipped one lot of oxidized lead ore. Development work and mill building were continued by the Cynide Gold Mining Co., but no ore was shipped or treated. The property is opened by several tunnels and equipped with a power plant, an aerial tramway, and a 200-ton cyanidation mill. Testing and development of its placer ground were continued by the Idaho Gold & Ruby Co., and the management is planning regular operations in 1924. The equipment includes six giants, one elevator, two steam shovels, and a gravity concentration plant for the treatment of black sand.

Port Hill district (*Klockmann*).—The Idaho Continental mine, at Klockmann, 26 miles west of Port Hill, was operated by a leasing company which treated lead ore in a 250-ton concentration-flotation mill. Several thousand tons of high-grade lead concentrate was shipped to the Bunker Hill smelter at Bradley. This is one of the largest producers of lead in Idaho outside of the Coeur d'Alene district, although it is not operated continuously on account of transportation difficulties.

BUTTE COUNTY

The Wilbert Mining Co. operated the Daisy Black group, near Howe, in the Dome district, and was preparing to ship ore mined during development work. A new transportation tunnel 2,300 feet long was completed and connection made with the work above.

CAMAS COUNTY

One lot of gold ore was shipped from the McCabe property, in the Little Smoky district, and ore was tested by amalgamation at the Liberty mine, near Fairfield. The Liberty property is owned by the American Mining & Development Co. and has a 50-ton mill equipped for amalgamation and concentration.

CANYON COUNTY

A little placer gold was won from the banks of Snake River near Melba.

CLARK COUNTY

The Skull Canyon Mining Co. shipped several cars of oxidized copper ore to the smelting plant at International, Utah.

CLEARWATER COUNTY

Moose Creek district.—Placer gold was mined from the Dodo Amended claim, near the Montana line, and sold in Montana.

Pierce district.—Three placers in the Pierce district produced $5,948 in gold and 70 ounces of silver, valued together at $6,005. The Bailey dredge was operated a short time, and hydraulic work was done at the Hen Creek property.

CUSTER COUNTY

Alder Creek district (Mackay).—Six deep mines in the Alder Creek district produced 18,488 tons of ore, containing $30,894 in gold, 51,391 ounces of silver, 1,453,485 pounds of copper, and 740,059 pounds of lead, valued in all at $338,501, or $18.31 a ton. All the output was first-class copper ore and lead ore shipped for smelting. The Idaho Metals Co. continued to operate the old White Knob property through lessees and shipped sulphide and oxidized copper ore to the smelter at Garfield, Utah, at the rate of more than 1,000 tons a month. The property is opened by 20 miles of underground workings, and 2,400 feet of development work was done in 1923. A large quantity of low-grade ore is on hand, for which a concentration mill is planned. The White Knob Mining Co., controlled by the United States Smelting, Refining & Mining Co., shipped nearly 2,000 tons of oxidized lead ore to the smelter at Midvale, Utah. Similar ore was shipped from the Horseshoe mine, operated by the Horseshoe Copper Co. The company has recently opened a new body of ore consisting principally of chalcopyrite and pyrrhotite. The Canady property produced oxidized lead ore, and the Custer Development Co., operating the Doughboy mine, made several shipments of sulphide lead ore.

Bayhorse district (Clayton).—Six deep mines in the Bayhorse district produced 9,562 tons of ore, containing $532 in gold, 314,121 ounces of silver, 119,698 pounds of copper, and 1,012,360 pounds of lead, valued in all at $346,572, or $36.24 a ton. Of the ore produced 335 tons was directly smelted and the remainder, 9,227 tons, was concentrated. The Ramshorn Mines Co. operated a 50-ton mill 70 miles west of Mackay and shipped concentrate and crude ore containing silver, copper, and lead. After fine grinding the ore is sulphidized and treated by flotation, and the recovery has been greatly increased. The company did about 3,000 feet of development work in drifts, raises, and crosscuts and late in the year was said to have opened up much new ore. Leasing operations were carried on in the Red Bird mine, owned by the Clayton Mining & Smelting Co. Several thousand tons of ore was treated in a small mill consisting of hand jigs. The property is said to have in reserve about 30,000 tons of ore that averages 10 per cent of lead and 8 ounces of silver to the ton. The conspicuous minerals are galena, anglesite, and cerusite, and interesting specimens of native silver in both anglesite

and galena are occasionally found. Test lots of copper-lead ore were shipped from the Good Friend and South Butte mines.

Boulder district.—The Livingston mine, 15 miles south of Clayton, near the East Fork of Salmon River, produced several lots of lead ore rich in silver. A power plant and mill are planned.

Stanley Basin district.—Five placers in the Stanley Basin district produced $737 in gold and 20 ounces of silver. A small dredge was operated a short time by the Sawtooth Dredging Co., and hydraulic mining was carried on at the Challis & Sturkey, Holman, and Jones placers.

Yankee Fork district.—Two placers and two deep mines in the Yankee Fork district produced 7 tons of ore, $1,057 in gold, 2,445 ounces of silver, 384 pounds of copper, and 534 pounds of lead, valued in all at $3,155. A test lot of rich silver ore was shipped from the Why Not mine, and a vein of rich gold ore was being developed in the Monte Cristo property. Placer gold was mined from the Rough Creek claim, 8 miles from Stanley.

ELMORE COUNTY

Bear Creek district.—Two deep mines and one placer in the Bear Creek district produced 115 tons of ore, $223,063 in gold, and 3,705 ounces of silver, valued together at $226,102. The ore was valued at $16.15 a ton. The Lison group, 2½ miles south of Rocky Bar, was operated by the Rocky Bar Mining Co. and produced ore which was treated by amalgamation in a 50-ton plant. At the junction of Feather River and Boise River the South Park Dredging Co. operated an electric dredge, which has a capacity of 6,000 cubic yards a day and treated more than 1,500,000 cubic yards of material. The operation of this plant and the dredge in Shoshone County has decidedly increased the placer output of Idaho.

Middle Boise district.—Small lots of bullion from deep mines and placers were shipped from the Hazel Queen and Idaho Bonanza properties. The Atlanta group, a producer of gold in 1916 and 1917, now owned by the St. Joseph Lead Co., was not operated in 1923.

Neal district.—Several hundred tons of ore was treated by cyanidation at the Homestake property, near Mayfield, by lessees. The property, which is owned by the George F. Roth Co., was a producer of gold from 1901 to 1915; the output was large in 1911.

Pine Grove district.—A small quantity of ore from the Last Chance property was tested by amalgamation in a 5-stamp mill.

GEM COUNTY

Several lots of rich silver ore were shipped from the Gold Dollar and Stoddard claims, in the West View district.

IDAHO COUNTY

Much was written in the mining journals in 1923 concerning the exploitation of the gold deposits of the central part of Idaho, many of which are in Idaho County. A large production of gold has come from Idaho County, and as recently as 1917 the output was valued at more than $200,000. In the last five years, however, the

output has been small, as the mines lack modern means of transportation. The Elk City district is 52 miles from Stites, on the Northern Pacific Railway, which enters the region from the northwest. The Warren district is 57 miles from McCall, the nearest railroad station southwest of the gold districts, and Buffalo Hump, Orogrande, and Dixie are even more distant from railroads.

Camp Howard district.—Gold valued at $449 and 3 ounces of silver was produced from the Cape Horn, Wilson & Thomas, and Pine Bar placers.

Clearwater district.—The Cove placer, near Grangeville, was operated for a short time by hydraulic mining.

Dixie district.—A small lot of ore was treated by amalgamation at the L. & L. property, near Dixie.

Elk City district.—Two deep mines and three placers in the Elk City district produced 111 tons of ore, $1,898 in gold, and 36 ounces of silver, valued together at $1,928. The ore had an average value of $11.15 a ton. The principal operation was that of the Homestake Gold Mining Co., which owns the American Eagle mine, opened by a tunnel to a depth of 300 feet. A 10-stamp mill equipped for amalgamation was operated a short time, but the mill broke down soon after operations started. The company did 500 feet of development work, but operations are expensive, as the mine is 60 miles from Stites, the nearest railroad station. The largest placer operations were carried on at the Erickson and Red Horse properties.

Florence district.—The Big Three Gold Mining Co. owns property near Florence on which a vein of rich gold ore is being developed. One lot of ore was treated by amalgamation as a test.

Maggie Creek district.—The Discovery placer, on Bridge Creek, 14 miles from Kooskia, produced a small lot of placer bullion.

Marshall Lake district.—The Holte property, formerly a large producer of gold, was idle in 1923, but the Sherman Extension, a neighboring property, produced gold ore, which was treated by amalgamation.

Newsome district.—The Moose Creek placer, near Newsome, produced a little placer gold from bench gravel.

Orogrande district.—Development work on the Center Star and Gold Zone properties opened considerable gold ore of milling grade.

Simpson district.—Placer gold from the operations of prospectors along Salmon River near Lucile was sold to stores at Riggins.

Tenmile district.—The Tippie placer, in Tippie Gulch, 7 miles from Newsome, produced a little placer gold washed from stream gravel.

Warren district.—Three deep mines and seven placers in the Warren district produced 439 tons of ore, $18,820 in gold, and 509 ounces of silver, valued together at $19,237. The ore was valued at $30.60 a ton. A slight increase was recorded in the output of the Little Giant mine, operated by the Unity Gold Mines Co., the largest producer of gold in the county. Several hundred tons of rich gold ore was treated in a 10-stamp mill equipped for amalgamation. The company completed the construction of a hydroelectric plant and did considerable development work. Small lots of gold ore from the New Era and Gayety Mountain properties were also treated by

amalgamation. The placer production consisted of $5,762 in gold and 50 ounces of silver, most of which came from the Golden Rule placer and the Buck diggings.

LATAH COUNTY

Gold Creek district.—Sluicing operations on Gold Creek resulted in the production of placer gold of exceptional fineness from the Lead To claim.

Hoodoo district.—A little placer gold was mined from the Hard Work and Annie placers, near Harvard.

LEMHI COUNTY

Mine production of gold, silver, copper, and lead in Lemhi County, Idaho, in 1923

	Number of producers	Ore	Gold [a]	Silver [a]	Copper	Lead	Total value
		Short tons		*Fine ounces*	*Pounds*	*Pounds*	
1923	25	43,400	$20,471	125,682	1,314,059	4,959,304	$663,848
Increase or decrease from 1922	−8	+14,965	+889	+26,755	+592,879	+525,060	+204,097

[a] Includes placer production

The value of the metal output of Lemhi County increased in 1923 as a result of activity in the production of lead ore at Gilmore and copper ore near Salmon. In 1912, when dredging was done near Salmon and the production of lead was large, the output of the county was valued at $1,221,048, nearly double that of 1923. A publication on the new copper deposits of Lemhi County is being prepared by the Geological Survey, and an article [3] summarizing the main features of this report was published in August.

Eldorado district (*Salmon*).—Two mines in the Eldorado district produced copper ore valued at $190,747, or $7.45 a ton. Most of it was concentrated. The Harmony Mines Co. produced considerable copper concentrate, which was hauled 8 miles north to Salmon and shipped to the smelter at International, Utah. The plant was operated continuously on sulphide ore made up principally of chalcopyrite, chalcocite, and pyrite. The Pope Shenon mine was operated by lessees, and several thousand tons of copper ore was treated in the 50-ton concentration plant. The concentrate is hauled 10 miles northwest to Salmon, on the Gilmore & Pittsburgh Railroad. The mine is said to have in reserve about 20,000 tons of ore containing 6 per cent of copper. Operations have been fairly successful since the milling process was changed from volatilization to concentration. The lowest tunnel is 800 feet long, and most of the work of 1923 consisted in driving raises from this level. To open more sulphide ore at depth considerable sinking or the driving of a longer tunnel will be required.

[3] Ross, C. P., A new copper district near Salmon; Eng. and Min. Jour.-Press, Aug. 9, 1924, p. 205.

Eureka district.—At the Tormey property, southwest of Salmon, several thousand tons of sulphide copper ore has been opened. A 50-ton concentration plant, a tramway, and a power plant were installed in 1923.

Indian Creek district (Ulysses).—The Ulysses mine was operated intermittently by the Buchanan Gold Mining & Leasing Co. Part of the ore was treated by amalgamation, and lessees also treated ore by concentration and cyanidation.

Junction district.—Five deep mines in the Junction district produced 340 tons of ore, containing $2,346 in gold, 3,110 ounces of silver, and 97,975 pounds of lead, valued in all at $11,754, or $34.57 a ton. The principal producers were the Baby Joe, Leadville, Ray, and Kimmel mines. Several lots of first-class ore were shipped from the Baby Joe and Leadville properties. Rich gold ore was shipped from the Ray mine, which was operated for a short period by the Barnes King Development Co., of Butte, Mont.

Mackinaw district (Leesburg).—Five placers in the Mackinaw district produced $3,530 in gold and 13 ounces of silver. The principal operation was that of the Hockensmith placer, on Arnett Creek, where stream and bench gravel was mined by hydraulicking. Sampling and testing work was done at the Italian mine, an old producer of gold.

Mineral Hill district.—Gold was produced from the Fool Hen placer and other claims near Shoup, on Salmon River. The Speculation or Sandilands group was operated by the Britannic Mining Co., and a small flotation mill was installed.

Pratt Creek district.—The Gladstone group was operated by lessees, and one lot of ore was treated by amalgamation. The property is said to have considerable free-milling gold ore in reserve, and development work was carried on from May to December.

Spring Mountain district.—One lot of oxidized lead ore was shipped from the Iron Mask mine, which was operated by the Idaho Minerals Co.

Texas district (Gilmore).—Four deep mines in the Texas district produced 16,639 tons of ore, containing $6,879 in gold, 119,357 ounces of silver, 33,736 pounds of copper, and 4,834,470 pounds of lead, valued in all at $448,124, or $26.93 a ton. About half the ore was first-class shipping product, and the remainder was reduced to 934 tons of lead concentrate. The Pittsburg-Idaho property was operated by a receiver, and both crude ore and concentrate were shipped to the smelter at Midvale, Utah. This property was the largest producer of lead in Lemhi County, but it has only a small quantity of ore in reserve. Several thousand tons of oxidized lead ore was shipped from the Latest Out mine, and 2,000 feet of development work was done. The company paid a dividend of $20,000 in 1923. The mine has been a constant producer since 1910 and is said to have 40,000 tons of low-grade ore in reserve. About 1,000 tons of first-class ore was shipped from the Gilmore mine, and a milling test was made on concentrating ore.

Yellow Jacket district.—A small lot of copper ore containing considerable silver was shipped from the Columbia property. Much work was done by the New York-Idaho Exploration Co. at the old Yellow Jacket property in cleaning out old tunnels and the construction of roads and buildings, but no ore was either shipped or

treated. The mine was a producer of gold in the past and under the direction of the Mandarin Mines Corporation produced gold bullion from 1911 to 1914.

Reno district (unorganized).—One lot of oxidized lead ore was shipped from the Cabin mine, near Reno.

OWYHEE COUNTY

The total metal output of Owyhee County in 1923 was valued at $33,339, an increase of $4,348. From 1863 to 1923 the county produced gold valued at $21,674,700 and 24,529,712 ounces of silver, or a value for both metals of $40,604,013.

Carson district (Silver City).—Ten deep mines in the Carson district produced 406 tons of ore, containing $6,389 in gold, 28,897 ounces of silver, 280 pounds of copper, and 77 pounds of lead, valued in all at $30,131, or $74.21 a ton. The largest part of the production came from first-class silver ore shipped from the Florida Mountain, formerly the Trade Dollar property. The mine was in litigation, but ore was shipped by lessees. Other small lots, principally silver ore, were shipped from the Bergh, Washington Gulch, Banner, California, Gold Bug, Never Sweat, and Pauper claims. At the Never Sweat mine considerable development work was done preparatory to using a new 50-ton mill equipped for amalgamation and concentration, which was completed in January, 1923. Ore was also mined, though not shipped, from the Mountain Chief and Village Blacksmith mines.

Flint district.—The Flint property was operated by the Precious Metals Mines Co., and several lots of rich silver ore were shipped to smelters in Utah. The main tunnel is 2,000 feet long, and a large body of ore has been opened to a depth of 675 feet. The ore contains galena, pyrite, chalcopyrite, sphalerite, tetrahedrite, and other silver-bearing minerals. Part of the old stamp mill was revamped and equipped with flotation machines.

French district.—The Red Jacket Gold Mining Co. mined gold ore while doing development work on the Dernier Resorte group and installed a small mill equipped for amalgamation and concentration. The Great Western property was also under development.

Steel district.—The Demming property was active in 1923, and much work was done in drifting. The milling plant was rebuilt and the treatment changed from flotation to cyanidation.

SHOSHONE COUNTY

Mine production of gold, silver, copper, lead, and zinc in Shoshone County, Idaho, in 1923

	Deep mines	Placers	Ore	Gold	Silver	Copper	Lead	Recoverable zinc	Total value
			Short tons		*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
1923	38	5	1,535,011	[a]$272,498	[a]6,117,621	599,555	228,852,538	27,952,749	$23,297,547
Increase from 1922	2	------	285,475	126,633	1,427,524	258,414	46,420,257	23,886,939	8,150,005
Total, 1884–1923	------	------	----------	6,745,400	200,546,825	74,152,036	[b]3,288,807	454,291,332	539,465,657

[a] Includes placer production of $243,604 in gold and 2,591 ounces of silver.
[b] Short tons.

The value of the metal output of Shoshone County, which comprises the Coeur d'Alene region, was $8,150,005 more than in 1922; the gain was due mainly to the increased quantity of silver, lead, and zinc but partly to the increase in the price of lead. The average value of the ore from deep mines in 1923 was $15.02 a ton, and the value in gold and silver was $3.29 a ton. The kinds of ore (nearly all lead ore and lead-zinc ore) and the contents of each kind have been given in the preceding tables. Most of the ore was milled and yielded 247,602 tons of concentrates, valued at $77.44 a ton. Seventeen milling plants, having a combined daily capacity of approximately 6,425 tons, were active during the year. Fifteen of these mills were concentration plants, and all but one of them had flotation equipment. In general, the mining industry of Shoshone County was in a better condition than it had been since the World War, on account of the high price of lead and the activity of the large producers. Much prospecting was done near Burke, Mullan, Wallace, and Kellogg, and a number of deposits of commercial value were opened. The development work done at the Tamarack & Custer, Success, and Galena properties was especially successful. A recent bulletin [4] describes the geology and ore deposits of the region. The State mine inspector's annual report [5] gives a list of the operators by counties, an interesting bibliography, and valuable data regarding the progress of the mines.

Beaver district.—Two deep mines and two placers in the Beaver district produced 141,678 tons of ore and tailings, $336 in gold, 184,163 ounces of silver, 10,039 pounds of copper, 9,850,368 pounds of lead, and 19,726,654 pounds of recoverable zinc, valued in all at $2,183,763. The ore had an average value of $15.41 a ton. The output consisted principally of ore and tailings which were concentrated into lead and zinc products. The Callahan Zinc-Lead Co. was active nine months of the year, during which it shipped an average of more than 3,000 tons of zinc concentrate and lead concentrate a month. The company did 5,000 feet of development work and is said to have 150,000 tons of ore in reserve. According to the statement to the county assessor, 155,103 tons of ore was mined, which had a gross value of $1,254,992. The cost of extraction was $811,273, the freight and treatment charge was $338,433, the cost of betterments and repairs was $63,402, and the net profit was $41,884. Extracts from the company's report follow:

> During the 12 months' period a winze was driven on the vein a depth of 200 feet below the No. 11, our lowest working level. At a point 100 feet below the No. 11 a small station was cut and the vein explored, showing continuous ore of narrow widths for a distance of approximately 140 feet in length.
>
> At the bottom of the winze, or 200 feet below the No. 11 level, the vein is being explored, which will prove up ore conditions at this depth and will determine our future plans as to the development of ore bodies at greater depth. With the winze development, our lowest level is now 2,800 feet below the grass roots.
>
> On the winze level a change in the formation was first noted, a hard quartzite appearing in thick ribs. The occurrence of quartzite at this depth in the Prichard slates is unusual. * * *

[4] Umpleby, J. B., and Jones, E. L., jr., Geology and ore deposits of Shoshone County, Idaho: U. S. Geol. Survey Bull. 732, 1923.

[5] Campbell, Stewart, Twenty-fifth annual report of the mining industry of Idaho, for 1923.

A crosscut was driven south from our main tunnel level, starting from a point 120 feet west from our old shaft station and continued for a distance of 2,900 feet to our south side line. Several small quartz veins were exposed, slightly mineralized. The purpose of this crosscut was to prove up our property to the south of the original Interstate and Callahan veins. * * *

Development work consisted of 5,290 feet, principally in crosscuts and drifts. * * *

Total estimated ore reserves in the Callahan property on January 1, 1923, were approximately 165,000 tons. During the year there was added about 60,000 tons. There was mined during the nine months that the mine was in operation 155,103 wet tons of ore. * * *

The mill was in continuous operation for the full nine months' period, doing excellent work, turning out a high-grade zinc and lead product, with an exceptionally high recovery. Two additional K. & K. flotation machines were installed in our selective lead unit, so that with the exception of a small percentage of our lead, all of our product was made and shipped as flotation concentrates, the zinc product averaging 51.5 per cent zinc, and the lead product 56.4 per cent lead, with 19.2 ounces silver.

The zinc concentrate (22,508 tons) contained 46,009 ounces of silver, 2,055,121 pounds of lead, and 23,207,828 pounds of zinc (gross). The lead concentrate (7,829 tons) contained 150,761 ounces of silver and 8,852,843 pounds of lead.

Several lots of lead ore were shipped from the Sunset mine, on Sunset Peak, by lessees. Placer gold from the Darnell claim, near Murray, was mined by sluicing.

Coeur d'Alene district.—The Yukon Gold Co. operated a large electric dredge on Prichard Creek which has a capacity of 5,000 cubic yards a day. The plant was operated the entire year and was the largest producer of gold in Idaho. The company's annual report for 1923 says:

The dredge on the property of the Coeur d'Alene Mining Co., Prichard Creek, mined 1,321,626 cubic yards, which yielded $244,803, or an average of 18.5 cents per yard. Costs, excluding depreciation, were $88,063, or 6.7 cents per cubic yard. The operating profit was $156,740. Values were higher than in previous years, and returns were correspondingly greater.

Workable ground on upper Prichard Creek remains to be dredged, and an area along lower Prichard Creek may be worked later, after which the dredge will probably be moved to other fields. Along the rim of the deposit some gravel is left which can not be worked by dredge but may be treated by hydraulic methods.

Eagle district.—Several lots of rich sulphide lead ore were shipped from the Jack Waite property, which is opened by two tunnels, 1,400 and 2,400 feet long. The Eagle placer, near Murray, was worked a short time by sluicing and hydraulicking.

Evolution district.—Four deep mines in the Evolution district produced 3,590 tons of ore, containing $275 in gold, 128,069 ounces of silver, 15,715 pounds of copper, and 739,023 pounds of lead, valued in all at $159,334, or $44.38 a ton. Most of the output came from the Yankee Boy and Western Union mines. About 600 feet of development work was done in drifting and shaft sinking at the Western Union property, which produced oxidized lead ore. The Sunshine Mining Co. operated the Yankee Boy mine and treated considerable ore in a 50-ton flotation mill. Several hundred tons of lead concentrate, particularly rich in silver, was shipped to the Bunker Hill smelter. The Argentine property, operated under

lease, produced several test shipments of silver ore and concentrate, and one lot of silver ore was shipped from the Polaris mine.

Hunter district (Mullan).—Three deep mines in the Hunter district produced 344,427 tons of ore and old tailings, containing $8,438 in gold, 1,525,631 ounces of silver, 51,796 pounds of copper, 56,716,267 pounds of lead, and 6,198,463 pounds of recoverable zinc, valued in all at $5,658,704, or $16.43 a ton. The output consisted of 285,261 tons of ore concentrated, 39,336 tons of first-class ore, and 19,830 tons of old tailings. The Morning mine, owned by the Federal Mining & Smelting Co., was operated the entire year and produced first-class shipping ore, as well as ore that was milled and separated into lead concentrate and zinc concentrate. The 1,000-ton mill is equipped for wet concentration and flotation. More than 6,000 feet of development work was done in drifts, crosscuts, and raises. According to the statement to the county assessor, 300,668 tons of ore was mined, which had a gross value of $4,778,361. The cost of extraction was $2,028,824, the freight and treatment charge $1,870,763, the cost of betterments and repairs $82,322, and the net profit $796,452. Dividends paid by the Federal Mining & Smelting Co. from the earnings of all properties amounted to $839,034. The printed annual report of the company for 1923 gives the following statement of the general manager:

> The earnings of the Morning mine in the year 1923 amounted to $847,971.71, being an increase of $343,529.68 over the earnings of the previous year. It was the best year in the history of the mine, with the exception of 1916 and 1917, the years of the war boom.
>
> The volume of ore mined was 295,728 tons, the average metal content of which was: Lead, 10.5 per cent; silver, 4.4 ounces per ton; zinc, 5.1 per cent. * * *
>
> Explorations have been conducted in the upper part of the mine, in areas abandoned years ago when the mill recovery of the metals was also lower. Considerable success has attended this work, and a good tonnage of ore will be obtained.
>
> I believe that we can still count on a further life of at least five years for the Morning mine.

Since 1912 the mine has produced 3,677,199 tons of ore, and the net earnings have been $6,463,290. The developed reserves at the end of 1923 were 863,300 tons of ore, equivalent to about 107,900 tons of lead concentrate, 34,500 tons of zinc concentrate, and 86,330 tons of crude lead ore.

The Gold Hunter mine, which has been operated by lessees for several years, produced several thousand tons of crude ore and concentrate. In November work was resumed on company account, and the 500-ton concentration-flotation mill was active. Other than the mine ore, considerable old tailing was concentrated. Development work consisted of 2,400 feet of tunnel and shaft work. According to the statement to the county assessor, 26,814 tons of ore was mined, which had a gross value of $321,835. The cost of extraction was $141,559, the freight and treatment charge $184,122, and the net loss $3,846.

The fire at Burke in July interrupted work on the Star crosscut from the 2,000-foot level of the Hecla mine. About 2,000 feet must still be driven to reach a point below the ore in the Star ground.

The Independence Lead Mining Co. did some prospecting from the tunnel of the National Copper Mining Co., and diamond-drill work opened a new ore body in the Copper King property, near Mullan. Ore of milling grade was said to have been opened in the Alice property, which was a producer in the past, especially in 1912.

Lelande district (*Burke, Mace, Frisco*).—Six deep mines in the Lelande district produced 384,394 tons of ore, containing $6,486 in gold, 1,831,990 ounces of silver, 228,037 pounds of copper, 58,361,256 pounds of lead, and 248,888 pounds of zinc, valued altogether at $5,644,451, or $14.68 a ton. Of the ore, 369,084 tons was reduced to 50,908 tons of concentrates and 15,310 tons was shipped as crude ore. The largest producer of the district was the Hercules mine, developed by more than 16 miles of underground work. Lead ore was treated in a 700-ton concentration-flotation mill at Wallace, and first-class ore was shipped from Burke. The product is shipped to East Helena, Mont., where three blast furnaces, moved from the plant at Northport, Wash., are smelting the additional ore from the Tamarack & Custer and Hercules properties. According to the statement to the county assessor, 41,501 tons of ore and concentrates was shipped, which had a gross value of $3,122,773. The cost of extraction was $1,425,249, the freight and treatment charge $931,882, the cost of betterments and repairs $3,597, and the net profit $762,044. Dividends were not published. Since 1901 the mine has produced at the rate of more than 1,200,000 ounces of silver and 30,000,000 pounds of lead a year.

The Hecla mine, a large producer of shipping and milling ore, was operated from January to July. The mine plant was destroyed by fire July 13, after which production ceased. Late in the year a new and substantial surface plant was under construction, and early in 1924 shipments were resumed. According to the statement to the county assessor, 156,450 tons of ore was mined, which had a gross value of $2,880,768. The cost of extraction was $1,189,123, the freight and treatment charge $457,635, the cost of betterments and repairs $317,251, and the net profit $916,759. Dividends amounted to $1,150,000 in 1923, making a total of $11,105,000. The following notes are taken from the printed annual report for 1923:

> The shareholders were advised by circular letter of the disastrous fire which destroyed most of the surface plant at the mine on July 13, 1923, and of plans for reconstruction which were then in progress. We are again on a producing basis, although reconstruction is not complete. The first ore was hoisted January 27, 1924, and the first ore sent to the concentrator the following day. Production was gradually raised to 700 tons daily. We are now building an ore-sorting plant, which, when complete, will permit the handling of a total of 850 tons daily, which will make production equal to that in effect before the fire. * * *
>
> Work to date on the Wide West claims has been disappointing. When we intersected the vein in the lower tunnel we found ore of commercial grade but not in commercial quantity. At a later date this work will be resumed, the two levels connected, and an effort made to discover whether ore exists in commercial quantity between them.
>
> The work of sinking a winze below the 2,000-foot level was commenced during the year. * * * Development work, which was also interrupted by the fire, consisted of 8,126 feet, including 2,225 feet driven in the crosscut on the 2,000-foot level which will open the Star property at depth. Most of

the work was done in the Wide West ground and on the 2,000-foot level. * * *

Ore reserves amount to 1,924,935 tons, and the surplus December 31, 1923, was $1,984,947.

Of the ore mined, 136,912 tons was milled, making 19,088 tons of concentrate. This, with 8,529 tons of crude ore, was smelted and contained 774,316 ounces of silver and 25,775,188 pounds of lead. The production of the Hecla mine for 20 years was 561,794 tons of crude ore and concentrate, containing 15,946,892 ounces of silver, 554,999,329 pounds of lead, and 941,229 pounds of gross zinc.

Lead ore was shipped by lessees from the Mace and Frisco groups, owned by the Federal Mining & Smelting Co. The property at Mace produced 1,831 tons of ore, which was mined and treated at a loss of $4,156. According to the statement to the county assessor, 816 tons of ore was mined from the Frisco mine, which had a gross value of $62,266. The cost of extraction was $38,851, the freight and treatment charge $16,663, and the net profit $6,752.

Much development work was done by the Marsh Mines Consolidated Co., and several hundred tons of lead ore was shipped by lessees. The Ajax Mining Co., whose property at Burke is extensively opened by prospect tunnels, did 3,000 feet of tunnel work and later opened a large body of silver-lead ore.

Placer Center district (*Sunset*).—Four deep mines in the Placer Center district produced 166,797 tons of ore, containing $3,266 in gold, 801,657 ounces of silver, 134,300 pounds of copper, 26,144,533 pounds of lead, and 1,741,744 pounds of recoverable zinc, valued in all at $2,628,923, or $15.77 a ton. The output consisted of 5,197 tons of first-class lead ore and 161,600 tons of mill ore, which was reduced to 31,018 tons of concentrate. The Tamarack & Custer Consolidated Mining Co. operated its mine and 400-ton concentration-flotation plant throughout the year and treated more than 100,000 tons of ore at Frisco. Development work consisted of 5,000 feet of drifting and crosscutting. The property was opened at depth by the Mammoth tunnel, through which ore will eventually be delivered to the mill in Canyon Creek instead of being carried 2 miles by aerial tramway. A large quantity of mill ore is held in reserve. The principal minerals are galena, cerusite, and sphalerite. Plattnerite, a rather rare mineral, occurs with the other lead minerals. According to the statement to the county assessor, 27,089 tons of ore and concentrate was shipped to East Helena, Mont., which had a gross value of $1,872,842. The cost of extraction was $854,931, the freight and treatment charge $480,269, the cost of betterments and repairs $157,593, and the net profit $380,049. Dividends of $300,000 were paid in 1923. It is planned to increase the capacity of the milling plant in 1924.

The Success mine was rejuvenated by the opening of a new ore body on the 700 and 860 foot levels, and $372,893 was received from the sale of ore and from royalties. The drift on the 700-foot level was said to be in ore for 200 feet, and the average width was 6 feet. On the 860-foot level ore was opened for 90 feet. Crude lead ore and concentrate were shipped to East Helena, Mont., throughout the year, and lead-zinc concentrate to the electrolytic plant at Great

Falls, Mont., after July. The 200-ton milling plant is equipped for table concentration, magnetic separation, and flotation. According to the statement to the county assessor, 53,721 tons of ore was mined, which had a gross value of $709,711. The cost of extraction was $262,417, the freight and treatment charge $336,818, the cost of betterments, development, and repairs $97,269, and the net profit $13,207.

The Galena property, in Lake Gulch, is owned and being developed by the Callahan Zinc-Lead Co. Nearly 2,000 feet of work was done in 1923 in drifts and shaft sinking, and the ore reserves are estimated at 225,000 tons of silver-lead mill ore. The company's annual report for 1923 gives the following notes:

> The Galena property is situated 3 miles from Wallace and about 1 mile up Lake Gulch. It is connected by a good wagon road with our loading station, on the main line of the Oregon-Washington Railroad & Navigation Co. and tracks of the Northern Pacific Railroad. * * *
>
> During the year work in the tunnel level was continued without interruption, a total of 1,770 feet being driven, of which 1,220 feet was in drifting along the vein and 550 feet in cross cutting. Galena ore was exposed for practically the entire length of drifting, but not always in commercial grade or quantity. * * *
>
> Late in 1923 our company acquired the adjoining property of the Coeur d'Alene Vulcan Mining Co., consisting of eight patented lode claims and 80 acres of patented homestead land, suitable for mill site and tailings dump, which added about 220 acres to the area of the Galena property. The Galena holdings now consist of 32 mining claims and a splendid mill site, comprising in all approximately 550 acres.

Several lots of lead ore were shipped from the Rex and Sisters properties.

St. Joe district.—In the course of development work several lots of copper ore were shipped from the Montana-Idaho and Richmond properties, near Falcon. The Montana-Idaho Copper Co. owns the Monitor mine, which produced rich copper ore in 1906 and 1907. A tunnel 9,000 feet long was driven to open the mine at a depth of 1,800 feet, after which some drifting and raising was done. The Richmond Consolidated Co., a large producer from 1915 to 1919, was driving a 1,200-foot crosscut from the Montana-Idaho tunnel to facilitate the opening of the deposit at greater depth.

Summit district (Murray).—Five deep mines in the Summit district produced 227 tons of ore, containing $1,550 in gold, 632 ounces of silver, 44 pounds of copper, and 95,126 pounds of lead, valued in all at $8,734, or $38.48 a ton. Several lots of lead ore were shipped from the Monarch and Paragon properties, and gold ore from the Mountain Lion mine was treated by amalgamation. A little bullion from the Golden Chest mine, which was a large producer of gold in the past, was sold by a lessee.

Yreka district (Kellogg).—Ten deep mines in the Yreka district produced 493,617 tons of ore and old tailings, containing $8,532 in gold, 1,641,398 ounces of silver, 138,518 pounds of copper, 76,687,376 pounds of lead, and 37,000 pounds of recoverable zinc, valued in all at $6,745,472, or $13.67 a ton. The output consisted of 10,070 tons of first-class ore, 21,720 tons of old tailings, and 461,827 tons of milling ore, which was reduced to 82,787 tons of concentrates. The Yreka district produced more lead than any other district in the State and had the most valuable output, but the Lelande district produced the largest quantity of silver.

The Bunker Hill & Sullivan Mining & Concentrating Co. operated its 1,200-ton milling plant throughout the year and shipped lead concentrate and crude ore to the Bunker Hill smelter, at Bradley, and also to smelting plants in Montana and California and at eastern points. According to the statement to the county assessor, 425,817 tons of ore was mined, which had a gross value of $5,968,275. The cost of extraction was $1,697,430, the freight and treatment charge $2,008,472, the cost of betterments and repairs $329,084, and the net profit $2,010,042, which includes $76,753 from royalties. Dividends aggregated $1,635,000 in 1923, making a total of $28,872,000. The following notes are taken from the company's printed annual report for 1923:

The mine yielded an increased output during the year, which, together with better prices for lead that are now still further strengthened, resulted in a substantial increase in operating profit over each of the two preceding years, notwithstanding the heavy decrease in prices received for silver after June 1, on which date the Government discontinued the purchase of domestic silver at $1 per ounce under the Pittman Act. Operating costs still remain relatively high, and there are no immediate prospects of it becoming possible to substantially lower them.

On July 13 last the town of Burke, Idaho, was completely destroyed by fire that spread to the hoist and surface plant of the Hecla mine, causing such damage to that property as to completely stop its production and thereby substantially decrease, for a period of six months, the output of the Bunker Hill smelter and refinery, which treats all the Hecla product. Repairs have been completed, however, and production from the Hecla mine has been resumed, so that it will be but a short time before the normal output of the smelter will be restored. * * *

Development of the Bunker Hill mine continued in a most satisfactory manner during the past year. Sinking of the main shaft was completed to the No. 17 level, with necessary sump and ore-loading pockets—a depth of 1,600 feet vertically below the Kellogg adit tunnel level. Crosscutting on this level passed through important ore during December and penetrated the main ore body on the 12th instant. * * * At this great depth, with rock structure and ore occurrence normal in every way, this disclosure gives assurance of ore resources greater than at any period in the past history of the mine. * * *

We have blocked out ore to date, 77,636 tons in the Stemwinder mine, 120,486 tons in the Sullivan mine, and 4,356,327 tons in the Bunker Hill mine. * * *

The mine was in operation for the full period of 12 months and produced 425,535 tons of concentrating ore and 282 tons from exploration at a cost of $1,375,818.

Thirty-three hundred twelve feet of shafts, drifts, and crosscuts were driven at a cost of $53,955. * * *

The West mill concentrators were in operation for the full year, during which time 12½ days were lost. * * *

During the year 427,941 tons of ore were concentrated, making the average work of the concentrators 1,172 tons per day, or say 1,214 tons per 24 hours of actual operation, at a cost of $338,526. * * *

The ore milled (425,817 tons) contained 3.46 ounces of silver to the ton and 9.39 per cent of lead. From this ore 72,586 tons of concentrates and middlings was produced, containing 69,757,010 pounds of lead and 1,177,631 ounces of silver. The total cost per pound of lead was 5.37 cents. From 1886 to 1923 the company has mined 10,314,275 tons of ore, having a gross value of $114,102,573. Net smelter returns were $68,334,078, and operating profit $38,348,682. The Bunker Hill smelter and refinery at Bradley were active during 1923, and two furnaces were kept in blast until the fire at Burke

eliminated shipments from the Hecla mine. The plant treated ore from Idaho, Montana, Washington, Oregon, British Columbia, and Alaska and was producing at the rate of about 200,000 ounces of silver and 3,500 tons of lead a month.

The Sierra Nevada property produced several thousand tons of milling ore and old tailings, which were treated in the mill of the Bunker Hill Co. According to the statement to the county assessor, 2,123 tons of ore was mined, which had a gross value of $82,079. The cost of extraction was $26,743, the freight and treatment charge $22,043, and the net profit $33,293.

The Caledonia Mining Co. continued to ship old stope fillings, from which a fair amount of silver and lead was produced, but no new ore was opened. According to the statement to the county assessor, 6,166 tons of ore was mined, which had a gross value of $135,937. The cost of extraction was $38,137, the freight and treatment charge $53,898, and the net profit $43,902. The company has a surplus of $374,860, but no adjustment has been made for the amount due the Government for income and excess-profit taxes.

The Hayes Co. treated old tailings in a 100-ton plant equipped for flotation and shipped considerable concentrate containing silver and lead to the Bunker Hill smelter. The Wyoming mine was operated under the control of the Federal Mining & Smelting Co. early in the year, when several cars of crude lead ore were shipped. In May the Idaho-American Mining Co. operated the Wyoming mine under lease and treated lead ore in the flotation plant formerly used by the Mullan Mining & Milling Co. The Big Creek mine, under the management of the Bunker Hill Co., produced lead ore rich in silver, as well as mill ore which was concentrated. Other shippers were the Highland Surprise and Sidney properties, on Pine Creek, which have much lead-zinc ore in sight. The advances in price of lead and zinc have stimulated activity in the Pine Creek region. The Nabob Silver-Lead Co. resumed operations and remodeled the mill in Pine Creek preparatory to selling lead and zinc products. Development progressed at the Lookout Mountain property, where drifting has opened an ore body 245 feet long and 14 feet wide, and a new concentration mill was under construction for the Amy Matchless mine.

TWIN FALLS COUNTY

A little placer gold was mined from the Sandy Bar placer, on the banks of Snake River near Twin Falls.

VALLEY COUNTY

Deadwood Basin district.—A small mill was operated at the Merry Blue & Union mine, and about 1,000 tons of ore was treated by amalgamation. About 300 feet of development work was done, but very little new ore was opened.

Lake City district.—Three placers in the Lake City district produced $410 in gold and 4 ounces of silver. The largest producer was the Ruby placer, on Boulder Creek, near McCall.

Thunder Mountain district.—A little placer gold was marketed from the Dewey property, which was operated by lessees.

WASHINGTON COUNTY

Heath district.—A test lot of gold ore from the Edna mine was treated by amalgamation.

Snake River district.—Gold was produced from the Sturgill Creek placer, near Robinette, Oreg.

Washington district.—One lot of silver ore from the North Star property was shipped to the smelter at Sumpter, Oreg.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN WASHINGTON

(MINE REPORT)

By C. N. Gerry [1]

PRODUCTION

SUMMARY

The value of the mine production of gold, silver, copper, lead, and zinc in Washington in 1923 was 83 per cent more than in 1922 and was close to the average of the last decade. A return to normal conditions was shown by the increased production of all five metals. Lead and zinc increased in Stevens County, copper in Snohomish County, and gold and silver in Ferry County.

A summary of the production by different kinds of ore from 1917 to 1922 given in Mineral Resources for 1922 shows that the gold, which is steadily decreasing, came principally from siliceous gold ore. Silver was about equally divided between siliceous ore and copper ore, and the production of copper, though never large, reached 2,645,022 pounds in 1916. Lead was produced in fairly large quantities from 1898 to 1923 and zinc from 1916 to 1923. Since 1860 the metal mines of Washington have produced gold, silver, copper, lead, and zinc valued at more than $42,000,000, most of which was in gold. No corporations have paid dividends on mining operations in the State since 1920, when the Electric Point Mining Co. distributed its profits.

Mine production of gold, silver, copper, lead, and zinc in Washington in 1923

	Number of producers	Ore	Gold [a]	Silver [a]	Copper	Lead	Recoverable zinc	Total value
		Short tons		*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
1923	36	56,900	$342,067	227,187	871,999	2,906,479	3,024,535	$1,065,666
Increase or decrease from 1922	−10	+20,854	+155,102	+22,141	+554,796	+1,525,280	+1,796,306	+484,858
Total, 1860–1923	------	------	28,784,590	8,397,278	17,945,662	44,893,554	8,322,290	42,102,767

[a] Includes placer production.

[1] The statistical tables given in this report were compiled by B. N. Lowry, of the United States Geological Survey.

ORE

The quantity of ore sold or treated in Washington increased nearly 58 per cent as a result of activity in Ferry, Snohomish, and Stevens counties. The average value of the ore increased from $16.02 a ton in 1922 to $18.70 in 1923, but the value in gold and silver decreased from $10.78 a ton to $9.26. Of the total output nearly 53 per cent was gold ore, most of which came from mines in Ferry County.

The total and average content of both crude ore and concentrates shipped are given on pages 409–410.

Ore and metals produced in Washington in 1923

Source	Ore			Gold		Silver	
	Number of producers	Short tons	Per cent	Fine ounces	Per cent	Fine ounces	Per cent
Dry gold ore	12	30,146	52.98	16,310.46	98.57	96,799	42.61
Dry silver ore	3	3,353	5.89	38.46	.23	30,230	13.31
Copper ore	2	11,128	19.56	80.01	.49	60,805	26.76
Lead ore	10	7,881	13.85	43.44	.26	36,819	16.21
Zinc ore	1	3,450	6.06				
Copper-lead ore	3	942	1.66	2.03	.01	2,511	1.10
Total deep mines		56,900	100.00	16,474.40	99.56	227,164	99.99
Total placers	6			73.09	.44	23	.01
		56,900	100.00	16,547.49	100.00	227,187	100.00
Increase from 1922		20,854		7,503.06		22,141	

Source	Copper		Lead		Zinc	
	Pounds	Per cent	Pounds	Per cent	Pounds	Per cent
Dry silver ore	349	0.04	4,467	0.15		
Copper ore	855,152	93.07				
Lead ore	1,341	.15	2,859,032	98.37		
Zinc ore					3,024,535	100.00
Copper-lead ore	15,157	1.74	42,980	1.48		
	871,999	100.00	2,906,479	100.00	3,024,535	100.00
Increase from 1922	554,796		1,525,280		1,796,306	

The gold ore was largely siliceous smelting ore mined at Republic, where several mines were active after being idle three years. Decidedly less ore was treated by amalgamation in Whatcom County than in 1922. The average content of all gold ores was $11.18 in gold and 3.21 ounces of silver to the ton.

Content of dry gold ore sold or treated in Washington in 1923

County	Ore	Gold	Silver
	Short tons	*Fine ounces*	*Fine ounces*
Ferry	24,480	13,380.74	96,597
Okanogan	38	35.03	40
Whatcom	5,628	2,894.69	162
	30,146	16,310.46	96,799

The Ruby mine and other prospects in Okanogan County produced silver ore, most of which was of milling grade. The silver ores averaged $0.24 in gold and 9.02 ounces of silver to the ton and a little copper and lead.

The copper ore, from Snohomish and Stevens counties, was largely milling ore and averaged $0.15 in gold and 5.46 ounces of silver to the ton and 3.84 per cent of copper.

Content of copper ore sold or treated in Washington in 1923

County	Ore	Gold	Silver	Copper
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*
Snohomish	8,998	57.01	10,018	647,918
Stevens	2,130	23.00	50,787	207,234
	11,128	80.01	60,805	855,152

The lead ore, part of which was milled, averaged $0.11 in gold and 4.67 ounces of silver to the ton and 18.14 per cent of lead.

Content of lead ore sold or treated in Washington in 1923

County	Ore	Gold	Silver	Copper	Lead
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Pend Oreille	34		46		31,233
Stevens	7,847	43.44	36,773	1,341	2,827,799
	7,881	43.44	36,819	1,341	2,859,032

Most of the copper-lead ore came from the Newport district, Pend Oreille County, and was milled. It averaged $0.04 in gold and 2.67 ounces of silver to the ton, 0.80 per cent of copper, and 2.28 per cent of lead.

Content of copper-lead ore sold or treated in Washington in 1923

County	Ore	Gold	Silver	Copper	Lead
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Ferry	66		1,394	3,520	12,782
Okanogan	26	0.24	654	1,446	7,701
Pend Oreille	850	1.79	463	10,191	22,497
	942	2.03	2,511	15,157	42,980

The zinc ore was first-class crude shipping product from the Northport district and averaged 43.83 per cent of recoverable zinc.

GOLD

The output of gold in Ferry County was three times that of 1922, increasing the mine production of gold for the whole State nearly 83 per cent. Nearly 18 per cent of the gold was obtained from ore treated in gold and silver mills, 81 per cent from ores shipped directly to smelters, and only about 1 per cent from concentrates and placers.

More than 98 per cent of the gold came from gold ore, largely from Ferry and Whatcom counties. The largest producers were the Knob Hill, Quilp, and Last Chance mines, at Republic, and the Boundary Red Mountain mine, in Whatcom County.

SILVER

The mine production of silver in Washington increased nearly 11 per cent. Nearly half the output came from Ferry County, where several mines resumed regular operations. Crude ore shipped to smelters supplied nearly 74 per cent of the silver, and concentrates nearly all the remainder. Gold ore contained 43 per cent of the silver, copper ore nearly 27 per cent, silver ore 13 per cent, and lead ore 16 per cent. The United Silver-Copper mine was the largest producer, and the Last Chance mine, at Republic, followed closely. Other producers were the Pyrargyrite (Ruby), Knob Hill, Quilp, Dominion, Santa Rita, and Sunset mines.

COPPER

The mine production of copper in Washington was more than doubled in 1923, though it is still below the normal quantity. Production from the Chewelah district, Stevens County, was unusually small, and as a result Snohomish County took first place after the Sunset mill resumed operations in April.

LEAD

The mine production of lead in Washington was more than doubled in 1923 as a result of additional shipments from Northport and Springdale, in Stevens County. The Gladstone mine, near Northport, was a large producer of shipping ore, and the Santa Rita mine, west of Springdale, produced much ore of milling grade. The Electric Point mine, formerly the largest producer of lead in Washington, was idle in 1923 and most of 1922.

ZINC

The recoverable zinc in ores produced in Washington in 1923 was 3,024,535 pounds, more than twice as much as in 1922. Zinc ore from the Black Rock mine, near Northport, was shipped to the electrolytic zinc plant at Trail, British Columbia, and to eastern zinc plants.

MINING INDUSTRY

After two years of quiet the mines of Washington experienced a mild revival in 1923, which was particularly noticeable at Republic, Northport, and Index. Though the price of silver was less, many of the mines responded to the increase in the prices of copper, lead, and zinc. Operations at Chewelah were small, but mining at Republic was active, as shown by the general effort of the principal companies to continue development work at greater depth. Mining of copper ore was resumed near Index, Snohomish County, considerable zinc ore was mined near Northport, and much prospecting was done for lead ore. The Electric Point mine was idle pending the

adjustment of the Federal tax. Development work was also done on several mines and prospects in Stevens and Pend Oreille counties in search of silver-lead ore, and a number of ore bodies have been opened which are said to justify the building of reduction plants. Many operators report that no development work was done on account of high taxes and the high cost of supplies, and others claim that under the State law it is difficult to procure funds from investors for the development of meritorious prospects.

METALLURGIC INDUSTRY

Nine milling plants in Washington were active in 1923. Six of these were concentration mills, four of which had flotation plants; two used amalgamation, and one cyanidation.

Ore and concentrate from mines in Washington were smelted mainly at Tacoma, Wash.; Trail, British Columbia; Bradley, Idaho; and East Helena, Mont. After the lead plant at Northport was dismantled the three blast furnaces were moved and added to the East Helena plant of the American Smelting & Refining Co. The only smelter operated within the State was the copper plant at Tacoma, which treats comparatively little ore from Washington. The plant at Trail, British Columbia, which includes departments for the treatment of copper, lead, and zinc ores, is close to the main producing areas in the eastern part of the State.

Ten per cent of the ore (5,640 tons) was treated by amalgamation or cyanidation, principally the former. The bullion contained gold valued at $60,036 and 166 ounces of silver, or an average in both metals of $10.67 a ton. For these mills no new supply of quicksilver was purchased during the year, and only a few pounds of potassium cyanide was consumed. The consumption of cyanide was 4.17 pounds per ton of ore treated and 6.25 pounds per ounce of bullion recovered.

More than 33 per cent of the output of ore was concentrated and produced 2,242 tons of concentrates, of which more than half was copper concentrates. The increase of 1,314 tons over 1922 was principally in copper and lead concentrates.

Metals produced from Washington concentrates in 1923

By counties

County	Ore to concentrating mills	Concentrates	Gold	Silver	Copper	Lead	Total value of concentrates
	Short tons	*Short tons*	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	
Okanogan	3,340	167	32.70	29,730	349	4,467	$25,419
Pend Oreille	850	79	1.79	463	10,191	22,497	3,490
Snohomish	8,960	1,047	56.71	9,953	637,288		103,014
Stevens	5,701	949	19.12	18,987	37,807	583,891	62,395
	18,851	2,242	110.32	59,133	685,635	610,855	194,318

By kinds of concentrates

Dry and siliceous		167	32.70	29,730	349	4,467	25,419
Copper		1,199	59.71	15,277	674,312		112,886
Lead		797	16.12	13,663	783	583,891	52,523
Copper-lead		79	1.79	463	10,191	22,497	3,490

Metals produced from Washington concentrates in 1923—Continued.

Average content

Kind of concentrates	Concentrates	Gold	Silver	Copper	Lead	Total value
	Short tons	*Fine ounces per ton*	*Fine ounces per ton*	*Per cent*	*Per cent*	
Dry and siliceous	167	0.20	178.02	0.10	1.34	$152.20
Copper	1,199	.05	12.74	28.12		94.15
Lead	797	.02	17.14	.05	36.63	65.90
Copper-lead	79	.02	5.86	6.45	14.24	44.18
	2,242	.05	26.38	15.29	13.62	86.67

Nearly 57 per cent of the ore was mined and shipped directly to smelters, and most of this came from Ferry and Stevens counties. Of the shipping ore, 75 per cent was dry and siliceous ore. All the copper ore and zinc ore shipped was sulphide, but most of the lead ore was carbonate.

Mine production of metals from Washington crude ore shipped to smelters in 1923

By counties

County	Ore	Gold	Silver	Copper	Lead	Recoverable zinc	Total value
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
Ferry	24,546	13,380.74	97,991	3,520	12,782		$358,370
Okanogan	65	31.50	1,190	1,446	7,701		2,379
Pend Oreille	34		46		31,233		2,223
Snohomish	38	.29	65	10,630			1,622
Stevens	7,726	47.30	68,573	170,768	2,243,908	3,024,535	445,052
	32,409	13,459.83	167,865	186,364	2,295,624	3,024,535	809,646

By kinds of ore

Dry and siliceous	24,519	13,411.98	97,133				$356,899
Copper	997	20.29	45,528	180,840			64,337
Lead	3,351	27.30	23,156	558	2,275,141		178,894
Zinc	3,450					3,024,535	205,668
Copper-lead	92	.26	2,048	4,966	20,483		3,848

Average content

		Fine ounces per ton	*Fine ounces per ton*	*Per cent*	*Per cent*	*Per cent*	
Dry and siliceous	24,519	0.55	3.96				$14.56
Copper: Sulphide	997	.02	45.66	9.02			64.53
Lead:							
Oxidized	2,108		.62		25.79		36.62
Sulphide	1,243	.02	17.57	.02	47.78		81.81
Zinc: Sulphide	3,450					43.83	59.61
Copper-lead: Sulphide	92		22.26	2.70	11.13		41.83
	32,409	.42	5.18	.29	3.54	4.67	24.98

REVIEW BY COUNTIES

Mine production of gold, silver, copper, lead, and zinc in Washington in 1923

County	Ore (short tons)	Gold		Silver	
		Fine ounces	Value	Fine ounces	Value
Ferry	24,546	13,380.77	$276,605	97,991	$80,353
Kittitas		59.99	1,240	19	15
Okanogan	3,417	78.51	1,623	30,926	25,359
Pend Oreille	884	1.79	37	509	417
Snohomish	8,998	56.98	1,178	10,018	8,215
Stevens	13,427	66.42	1,373	87,560	71,799
Whatcom	5,628	2,903.03	60,011	164	135
	56,900	16,547.49	342,067	227,187	186,293

County	Copper		Lead		Recoverable zinc		Total value
	Pounds	Value	Pounds	Value	Pounds	Value	
Ferry	3,520	$517	12,782	$895			$358,370
Kittitas							1,255
Okanogan	1,795	264	12,168	852			28,098
Pend Oreille	10,191	1,498	53,730	3,761			5,713
Snohomish	647,918	95,244					104,637
Stevens	208,575	30,661	2,827,799	197,946	3,024,535	$205,668	507,447
Whatcom							60,146
	871,999	128,184	2,906,479	203,454	3,024,535	205,668	1,065,666

Ore sold or treated, deep mines producing, and average value of ores in Washington in 1922 and 1923, by counties

County	Ore sold or treated, 1923 (short tons)		Number of deep mines producing		Average total value per ton [a]		Average value per ton in gold and silver [a]	
	Total	Increase or decrease	1922	1923	1922	1923	1922	1923
Chelan		−10	1		$17.30		$17.30	
Ferry	24,546	+15,242	9	7	12.73	$14.60	12.70	$14.54
King		−25	1		14.68		14.68	
Kittitas		−125	1		4.12		.25	
Okanogan	3,417	−3,179	5	7	10.82	8.19	10.56	7.87
Pend Oreille	884	+871	2	3	49.08	6.46	17.31	.51
Snohomish	8,998	+8,998		1		11.63		1.04
Stevens	13,427	+2,330	13	10	26.13	37.79	9.38	5.45
Whatcom	5,628	−3,248	1	2	10.81	10.66	10.81	10.66
	56,900	+20,854	33	30	16.02	18.70	10.78	9.26

[a] Placer product excluded.

CHELAN COUNTY

The Royal Development Co., which owns property 40 miles north of Leavenworth, was preparing to do development work on ore containing silver and copper.

FERRY COUNTY

Keller district.—The Addison Copper Co. shipped several lots of copper-lead ore to the Bunker Hill smelter, at Bradley, Idaho. The ore is hauled 23 miles south to Wilbur, on the Northern Pacific Rail-

way. The company is trying to finance further development work and may build a mill for the low-grade ore. The Iron Creek Mining & Milling Co. mined ore which is ready for market, but no shipments were reported in 1923.

Mine production of gold, silver, copper, and lead in Ferry County, Wash., in 1923

	Number of producers	Ore	Gold	Silver	Copper	Lead	Total value
		Short tons		*Fine ounces*	*Pounds*	*Pounds*	
1923	7	24,546	$276,605	97,991	3,520	12,782	$358,370
Increase or decrease from 1922	-3	+15,242	+190,919	+65,266	+3,493	+6,424	+239,605

Republic district.—Six deep mines in the Republic district produced 24,480 tons of ore, containing $276,605 in gold and 96,597 ounces of silver, valued together at $355,815, or $14.53 a ton. All the ore was shipped to smelters and used as silica flux. From 1896 to the end of 1923 the district produced 595,738 tons of ore, containing $7,494,698 in gold and 2,223,870 ounces of silver, valued together at $8,897,703. The largest producers in the district were the Last Chance, Quilp, Knob Hill, and Surprise mines. The Last Chance, which resumed operations late in 1922, was an active producer in 1923 at the rate of about 900 tons a month. All the ore mined came from stopes between the 500 and 650 foot levels. The company has considerable ore valued at $10 a ton in reserve, as well as a large quantity of lower-grade ore, and plans to develop the deposit at greater depth. The Quilp Mining Co. shipped more than 6,000 tons of gold ore to Trail, British Columbia, and did about 600 feet of development work in winzes and drifts. At a depth of 925 feet the ore is said to be 12 feet wide. From the Knob Hill mine, operated by the Balaklala Consolidated Copper Co., was shipped about 5,000 tons of rather high-grade gold ore for smelting. The output, however, is said to be limited by the requirements of the smelter at Trail, British Columbia. Shaft sinking was continued, and the 1,000-foot level was reached early in 1924. Development work was done by lessees at the Republic mine, and one lot of rich gold ore was shipped. The Northport Smelting & Refining Co. operated the Surprise-Lone Pine-Pearl group and shipped about 2,000 tons of first-class ore from the Surprise mine. No milling was done in the district, but considerable interest was shown in the development of the ore deposits at greater depth and in the possibilities for a custom mill for the district. A short article dealing with the work at these mines[2] was published in February.

KING COUNTY

The Apex mine, in the Miller River district, was operated by the Bondholders Syndicate Mining Co. Work consisted of road building and surface improvements. The company reports much ore in reserve. The principal mineral is arsenopyrite associated with gold,

[2] Gifford, W. W., Republic camp a steady producer: Min. Truth, Feb. 1, 1924.

silver, and lead. The erection of a mill and arsenic plant is being considered.

KITTITAS COUNTY

Four placers in the Swauk district produced $1,240 in gold and 19 ounces of silver, valued together at $1,255. The main producers were the Black Jack, Bigney, and Weninger placers.

OKANOGAN COUNTY

Conconully district.—The Peacock silver mine produced a shipment of copper-lead ore and a small lot of gold bullion. As the property is 14 miles from the railroad it is impossible to ship at a profit crude ore that is worth less than $40 a ton.

Myers Creek district.—Lessees operating the Gray Eagle mine shipped one lot of gold ore to the Bunker Hill smelter, at Bradley, Idaho. Ore was tested in a small amalgamation mill for the Mary Ann Creek Mining Co., near Molson, and a little placer gold was marketed from various claims in the district.

Nespelem district (Moses).—One test lot of silver ore was shipped from the Panama property, which is 35 miles north of Wilbur, the shipping point on the Northern Pacific Railway..

Palmer Mountain district.—Three mines in the Palmer Mountain district produced 3,355 tons of ore, containing $840 in gold, 30,091 ounces of silver, 349 pounds of copper, and 4,467 pounds of lead, valued in all at $25,878, or $7.71 a ton. The principal output of ore was that of the Ruby mine, which was operated for a short time by the Pyrargyrite Mining Co. A rich silver concentrate saved by flotation was shipped to Bradley, Idaho.

PEND OREILLE COUNTY

Metaline district.—The Bella May property produced one shipment of sulphide lead ore, which was smelted at East Helena, Mont. A test lot of similar ore was shipped from the Buzzell claim. The district produced considerable zinc ore from 1915 to 1918.

Newport district.—Several hundred tons of copper-lead ore was milled by the Bead Lake Gold & Copper Co., and the resulting concentrate was shipped to Midvale, Utah, and Bradley, Idaho. The concentration plant, which has a capacity of 100 tons a day, was remodeled and electrically equipped.

PIERCE COUNTY

The Tacoma Smelting Co. operated a copper smelter and refinery at Tacoma. Most of the charge is made up of ore from foreign countries. Some copper ore from Chewelah and Index was smelted in 1923.

SNOHOMISH COUNTY

The Sunset Copper Co., whose mine is 7 miles from Index, on the Great Northern Railway, shipped more than 1,000 tons of copper concentrate containing a little gold and silver. The ore occurs in three fissure veins in granite, and the company reports 80,000 tons

of copper ore in reserve. The milling plant, which has a capacity of 200 tons a day, is equipped with crushers, ball mills, tables, and flotation plant. The company produced much copper from 1916 to 1920 but was idle from January, 1921, to April, 1923.

STEVENS COUNTY

Mine production of gold, silver, copper, lead, and zinc in Stevens County, Wash., in 1923

	Number of producers	Ore	Gold	Silver	Copper	Lead	Recoverable zinc	Total value
		Short tons		*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
1923	10	13,427	$1,373	87,560	208,575	2,827,799	3,024,535	$507,447
Increase or decrease from 1922	−3	+2,330	+354	−15,548	−100,421	+1,480,471	+1,796,306	+217,494

In Stevens County, which is the most active mining area in the State, more lead ore and zinc ore was mined in 1923 than in 1922, but the output of copper ore with its accompanying silver decreased decidedly.

Bossburg district.—Lead ore valued at $11,748, or $46.80 a ton, was shipped from the Bonanza and Young America mines. Much low-grade ore is being opened by lessees.

Chewelah district.—From 1901 to the end of 1923 the Chewelah district has produced 364,807 tons of ore, yielding $73,843 in gold, 1,550,244 ounces of silver, 9,340,659 pounds of copper, and 267,662 pounds of lead, having a total value of $3,139,467. The United Silver-Copper Co. operated only a short time in 1923 but shipped both crude copper ore and concentrate to Tacoma, Wash. The company produced considerable copper from 1911 to 1923. The output of 1917 was more than 1,000,000 pounds of copper, but that of 1923 was only about 200,000 pounds. One test lot of silver-lead ore was shipped from the Silver Summit property.

Colville district.—The Old Dominion mine, 7 miles east of Colville, produced several lots of sulphide lead ore exceptionally rich in silver. The ore occurs as a replacement deposit in limestone. The company did 800 feet of development work, which opened some rich silver-lead ore 60 feet below the 600-foot level. Samples of the high-grade ore consisted of galena and wire silver. The mine was opened in 1885 and produced rich ore near the surface. Silver-lead ore was also opened at the Chloride Queen mine, 14 miles north of Colville.

Northport district.—Four deep mines in the Northport district produced 6,298 tons of ore, containing $1 in gold, 1,676 ounces of silver, 91 pounds of copper, 2,123,262 pounds of lead, and 3,024,535 pounds of recoverable zinc, valued in all at $355,685, or $56.48 a ton. All the output was first-class shipping ore, and a decided increase was made in both lead ore and zinc ore in 1923. Nearly 3,000 tons of lead ore was shipped from the Gladstone Mountain mine, the larger part of which was carbonate ore. The company did 1,400 feet of development work and opened 13 chimneys of ore in limestone.

It was the largest producer of lead in Washington and made several improvements at the mine, including a new compressor and hoist. An interesting article on the history of the mine and the occurrence of the ore[3] was published in November. The Electric Point mine was idle in 1923, as well as in 1922, as no settlement has yet been made in regard to the claim of the Federal Government for taxes. It is the only metal mine in the State that has recently paid dividends, the last one having been paid in 1920. The Washington Black Rock Mining Co. owns eight claims 6 miles southeast of Northport and shipped several thousand tons of zinc ore to Trail, British Columbia, and eastern zinc plants. The mine is opened to a depth of 250 feet by shaft and drifts. The ore, which is principally sulphide, was hauled 6 miles by truck to Northport. The property was active only part of the year, as operations were hampered by an inflow of water and by faults in the ore body. Toward the end of the year the company was building a 25-ton concentration plant equipped with crusher, rolls, jigs, and tables. Test lots of lead ore were shipped from the Lead Trust and Melrose properties.

Orient district.—The First Thought mine, 2½ miles from Orient, resumed operations and was said to have mined first-class gold ore which was ready for market, but no shipments were reported in 1923. The property was a large producer of gold from 1904 to 1910 and has in reserve much low-grade gold ore suitable for cyanidation.

Springdale or Cedar Canyon district.—The Cleveland mine, 18 miles west of Springdale, was operated by the Santa Rita Mines Co. and produced several thousand tons of lead ore, which was treated in a 50-ton mill equipped with tables and flotation cells. Rich lead concentrate was shipped to the smelter at Bradley, Idaho. The company has in reserve much sulphide ore, which contains about 10 per cent of lead and 5 ounces of silver to the ton. The ore body is reported to be 30 feet wide and more than 100 feet long.

Summit district.—The Consolidated Silver Mountain Mines Co. is developing a deposit of silver-lead ore at the Daisy property. The greater part of the year was spent in building a 50-ton concentration plant, which is equipped with crusher, rolls, tables, and flotation machines.

WHATCOM COUNTY

Mount Baker district.—The Boundary Red Mountain mine, south of Sardis, British Columbia, produced several thousand tons of gold ore, which was treated in a 10-stamp amalgamation mill. The output, however, was considerably less than that of 1922. The company did much drifting and raising in the development of the ore body. A lower crosscut tunnel, which will be approximately 2,000 feet long when the vein is reached, was driven 382 feet during 1923. The ore averages about $14 in gold to the ton, and the vein is said to be 26 feet wide on the 500-foot level. A short article describing the property[4] appeared early in 1923. The Lone Jack property, 22 miles northwest of Glacier, Wash., was operated by Brooks & Willis. A

[3] Gladstone leads State lead output; Min. Truth, Nov. 2, 1923.
[4] Boundary Red Mountain mine steady producer: Eng. and Min. Jour.-Press, Mar. 31, 1923, p. 597.

100-ton mill equipped with rod mills, amalgamation plates, and "K. & K." flotation machines was constructed during the year. Considerable money was also put into the equipment of a hydroelectric plant. The company reports considerable ore in reserve, part of which is mined and ready for treatment.

Slate Creek district.—The output of the Slate Creek district consisted of a small quantity of gold and silver from the Mammoth property, near Mazama, and a little bullion from several placer properties. The property of the Slate Creek Gold Mining Co. was operated by the Brown Development Co. Work consisted of 200 feet of tunneling, and the company reports a large reserve of low-grade gold ore.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN UTAH

(MINE REPORT)

By V. C. Heikes [1]

PRODUCTION

The output of ores of gold, silver, copper, lead, and zinc in 1923 from mines in Utah was more than double that of 1922, and the value of all metals except silver increased considerably. The published dividends by 13 producers in 1923 amounted to $10,024,648, which gives a total paid to stockholders since mining became profitable of $241,623,633.

Mine production of gold, silver, copper, lead, and zinc in Utah in 1923

	Number of producers	Ore	Gold [a]	Silver [a]	Copper	Lead	Recoverable zinc	Total value
		Short tons		*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
1923	150	12,752,998	$3,076,483	19,137,470	222,393,572	203,447,793	11,330,913	$66,472,911
Increase or decrease from 1922	−4	+7,192,964	+779,628	+1,866,370	+125,199,722	+68,115,649	+6,211,503	+26,048,712
Total, 1864–1923 [b]			107,385,773	452,893,629	2,780,803,913	4,835,242,751	239,465,502	1,226,037,496

[a] Includes small placer production.
[b] The total by years to the end of 1917 appears in U. S. Geol. Survey Prof. Paper 111, p. 127, 1920.

Copper ore was mined in greatest quantity, followed by lead-silver ore and dry and siliceous ores of silver. The total value of the ores was as follows: Dry gold ore, $316,204; dry gold and silver ore, $144,997; dry silver ore, $6,604,092; copper ore, $33,957,205; lead ore, $21,656,858; zinc ore, $2,049; copper-lead ore, $50,711; and lead-zinc ore, $3,740,265. The small placer output was valued at $530.

[1] Valuable assistance in the preparation of this report and the compilation of statistical tables was rendered by B. N. Lowry, of the United States Geological Survey.

Ore and metals produced in Utah in 1923

Source	Number of producers	Ore		Gold		Silver	
		Short tons	Per cent	Fine ounces	Per cent	Fine ounces	Per cent
Dry gold ore	9	17,903	0.14	9,333.57	6.27	88,881	0.46
Dry gold and silver ore	3	23,722	.19	3,095.32	2.08	43,532	.23
Dry silver ore	36	304,800	2.39	20,285.62	13.63	6,604,887	34.51
Copper ore	18	11,519,727	90.33	84,203.12	56.58	867,618	4.53
Lead ore	99	645,991	5.07	21,365.84	14.36	10,648,952	55.65
Zinc ore	2	48				56	
Copper-lead ore	5	971		24.96	.01	30,924	.16
Lead-zinc ore	14	239,836	1.88	10,490.94	7.05	852,617	4.46
Total deep mines		12,752,998	100.00	148,799.37	99.98	19,137,467	100.00
Total placer mines	4			25.49	.02	3	
		12,752,998		148,824.86	100.00	19,137,470	
Increase from 1922		7,192,964		37,714.50		1,866,370	

Source	Copper		Lead		Zinc	
	Pounds	Per cent	Pounds	Per cent	Pounds	Per cent
Dry gold ore	160,941	0.07	381,738	0.19		
Dry gold and silver ore	296,185	.13	25,378	.01		
Dry silver ore	2,395,460	1.08	5,951,587	2.92		
Copper ore	214,305,888	96.37	30,852	.02		
Lead ore	4,494,047	2.02	168,875,684	83.01	16,535	0.15
Zinc ore			1,067		28,346	.25
Copper-lead ore	90,624	.04	164,495	.08		
Lead-zinc ore	650,427	.29	28,016,992	13.77	11,286,032	99.60
	222,393,572	100.00	203,447,793	100.00	11,330,913	100.00
Increase from 1922	125,199,722		68,115,649		6,211,503	

The output of gold ore was valued at $316,204. It averaged 0.52 ounce of gold and 4.96 ounces of silver to the ton, 0.45 per cent of copper, and 1.07 per cent of lead. The total average value of all metals was $17.66 a ton. Most of the gold ore was mined from the Deer Trail mine, near Marysvale.

Content of dry gold ore sold or treated in Utah in 1923

County	Ore	Gold	Silver	Copper	Lead
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Beaver	3	2.92	1		
Box Elder	3	2.41	1		
Piute	14,316	6,210.57	73,666	13,535	328,968
Salt Lake	3,492	2,247.36	14,885	147,372	49,963
San Juan	10	6.71	2		
Sevier	8	13.60	13	34	
Tooele	71	850.00	313		2,807
	17,903	9,333.57	88,881	160,941	381,738

The dry and siliceous silver ores were mined by 36 producers in 1923, against 46 producers in 1922. These ores averaged $1.38 in gold, 21.67 ounces of silver, 7.86 pounds of copper, and 19.53 pounds of lead to the ton. The Tintic district, in Juab and Utah counties, had the largest number of silver-ore producers—21, who reported 190,539 dry tons—and 8 of these producers shipped 86,792 tons to

chloridizing-roasting plants at Silver City and Warm Springs. The largest producers of silver ore were the Tintic Standard, Chief Consolidated, and Grand Central mines, in the Tintic district; the Park-Utah and Ontario mines, at Park City; the Vipont Silver mine, in Box Elder County; and the Dalton & Lark mine (Bingham Mines Co.), at Bingham.

Content of dry silver ore sold or treated in Utah in 1923

County	Ore	Gold	Silver	Copper	Lead
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Beaver	95	1.19	1,304	734	3,995
Box Elder	31,721	1,965.56	775,198	11,545	169,576
Juab	105,523	12,032.41	1,852,594	1,580,565	2,107,645
Salt Lake	14,641	1,013.62	97,393	291,653	210,098
Sevier	7	1.21	59		
Summit	3,310	78.00	122,195	30,522	106,621
Tooele	13,113	8.30	40,175	28,755	256,181
Utah	85,026	404.04	1,498,293	312,626	1,967,995
Wasatch	51,364	4,781.29	2,217,676	139,060	1,129,476
	304,800	20,285.62	6,604,887	2,395,460	5,951,587

Copper ore represented 90 per cent of the total ore output of the State. The average content of this ore was 0.007 ounce of gold, 0.08 ounce of silver, and 18.60 pounds of copper to the ton, and the average value was $2.95. Salt Lake County was credited with the largest output, chiefly from the Utah Copper property, at Bingham.

The small quantity of copper-lead ore produced averaged 0.03 ounce of gold and 31.8 ounces of silver to the ton, 4.66 per cent of copper, and 8.47 per cent of lead and was valued at $52.22 a ton. This ore came from the Little Cottonwood, Ophir, and Silver Islet districts.

Content of copper ore and copper-lead ore sold or treated in Utah in 1923

County	Ore	Gold	Silver	Copper	Lead
Copper ore:	*Short tons*	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Beaver	78	1.55	519	12,532	915
Box Elder	93		26	18,111	256
Juab	1,754	320.41	25,280	169,425	29,302
Salt Lake	11,516,256	82,388.70	834,856	213,958,224	379
Tooele	36	1.46	240	5,839	
Utah	1,510	1,491.00	6,697	141,757	
	11,519,727	84,203.12	867,618	214,305,888	30,852
Copper-lead ore:					
Salt Lake	825	23.48	14,410	81,886	93,090
Tooele	146	1.48	16,514	8,738	71,405
	971	24.96	30,924	90,624	164,495

The output of lead ore was valued at $21,656,858. It averaged 0.03 ounce of gold and 16.48 ounces of silver to the ton, 0.35 per cent of copper, and 13.07 per cent of lead. The total average value of all the metals was $33.53 a ton. In 1922 there were 102 producers of lead ore, whose output was valued at $14,858,316, or $29.28 a ton.

Content of lead ore sold or treated in Utah in 1923

County	Ore	Gold	Silver	Copper	Lead
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Beaver	16,235	702.82	128,193	79,374	3,359,277
Box Elder	44		1,101	923	12,109
Iron	30		33	83	13,922
Juab	136,809	8,441.34	3,871,987	593,767	39,686,928
Piute	2,593	1,656.30	49,097	9,989	456,443
Salt Lake	165,303	3,838.46	936,989	1,351,474	36,323,116
Summit	173,809	3,501.00	2,650,851	917,100	38,578,852
Tooele	64,504	281.95	420,791	957,230	9,530,015
Utah	66,744	2,308.57	1,960,834	263,791	34,215,398
Wasatch	19,884	634.27	628,439	320,316	6,678,931
Washington	36	1.13	637		20,693
	645,991	21,365.84	10,648,952	4,494,047	168,875,684

Nearly all the recoverable zinc is to be credited to lead-zinc ore, 55 per cent of which came from Salt Lake County. Most of the ore from this county was concentrated at Midvale, where custom ores are milled. In 1923 several lots of lead-zinc ore were shipped to zinc-oxide plants in the Eastern States and to a western chemical plant that is equipped to make zinc chloride. Two small lots of zinc ore were produced in the Tintic district, Juab County, and American Fork district, Utah County.

Content of lead-zinc ore sold or treated in Utah in 1923

County	Ore	Gold	Silver	Copper	Lead	Zinc
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Beaver	864	13.00	3,411	210	107,671	156,372
Juab	820	5.00	5,400		153,584	330,061
Salt Lake	132,808	9,899.22	505,850	372,788	21,733,175	3,144,550
Summit	72,000	37.05	17,724	7,363	230,041	42,752
Tooele	151				14,064	96,965
Utah	238	.72	430		61,686	100,806
Wasatch	32,955	535.95	319,802	270,066	5,716,771	7,414,526
	239,836	10,490.94	852,617	650,427	28,016,992	11,286,032

METALLURGIC INDUSTRY

GENERAL FEATURES

Of the 25 milling plants operated in 1923 in Utah, 1 was equipped for concentration and cyanidation, 2 were chloridizing-roasting and leaching plants, 1 was equipped for amalgamation, and 21 were concentration plants. Thirteen of the concentration plants used tables followed by the oil-flotation process, which in some plants has almost replaced table concentration. Eight mills used ordinary table concentration, and one of these that was equipped for wet concentration by tables and flotation treated the dried concentrate by electrostatic separation. This method of separation may be replaced entirely by flotation in another year.

Cyanidation of the tailing after concentration of the heavier minerals was used at the Deer Trail mine, in Piute County, the only property using the process in Utah. Amalgamation of gold was

reported from San Juan County, where ore from the Dream mine was treated in a small 5-stamp mill.

The remaining remodeled units of the Utah Copper mill, at Magna, were started during 1923, and about 24,000 tons of ore a day was treated there in addition to 16,000 tons at the Arthur concentrator. The construction of the first unit of the Chief Consolidated mill for treating ore from its mines by concentration and volatilization was begun.

The different kinds of concentrates produced in Utah in 1923 are shown in the following tables. They contained 67 per cent of the gold, 17 per cent of the silver, 95 per cent of the copper, 29 per cent of the lead, and 93 per cent of the zinc. The corresponding percentages in 1922 were 55, 16, 92, 29, and 91.

Mine production of gold, silver, copper, lead, and zinc from Utah concentrates in 1923

By counties

County	Ore to concentrating mills	Concentrates	Gold	Silver	Copper	Lead	Recoverable zinc	Total value
	Short tons	*Short tons*	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
Beaver	658	149	4.89	2,363	258	66,518	18,931	$8,020
Box Elder	29,704	2,223	1,530.18	558,791	8,046	140,864	----------	500,884
Juab	47	9	.24	1,888	38	13,078	----------	2,475
Piute	----------	1,212	3,250.48	35,266	13,289	328,968	----------	121,092
Salt Lake	11,733,680	679,120	92,883.95	1,512,057	209,237,674	33,509,592	3,076,469	36,472,778
Summit	110,853	25,173	1,092.31	540,749	169,378	13,212,574	42,752	1,418,679
Tooele	59,816	23,684	118.61	370,715	926,729	6,668,415	----------	909,456
Utah	1,238	228	251.00	6,259	15,679	59,202	----------	16,770
Wasatch	32,955	18,833	535.95	319,802	270,066	5,716,771	7,414,526	1,217,379
	11,968,951	750,631	99,667.61	3,347,890	210,641,157	59,715,982	10,552,678	40,667,533

By kinds of concentrates

Kind of concentrates	Concentrates	Gold	Silver	Copper	Lead	Recoverable zinc	Total value
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
Dry and siliceous	9,018	2,204.53	569,188	189,282	148,722	----------	$550,540
Copper	588,707	81,582.48	814,282	208,370,507	----------	----------	32,984,635
Lead	137,528	15,593.06	1,817,577	1,919,114	58,381,700	----------	6,181,579
Zinc	15,102	276.01	144,853	162,254	1,158,595	10,414,205	937,605
Lead-zinc	276	11.50	1,990	----------	26,965	138,473	13,174

Average content

Kind of concentrates	Concentrates	Gold	Silver	Copper	Lead	Recoverable zinc	Total value
	Short tons	*Fine ounces per ton*	*Fine ounces per ton*	*Per cent*	*Per cent*	*Per cent*	
Dry and siliceous	9,018	0.24	63.12	1.05	0.82	----------	$61.05
Copper	588,707	.14	1.38	17.70	----------	----------	56.03
Lead	137,528	.11	13.22	.70	21.23	----------	44.95
Zinc	15,102	.02	9.59	.54	3.83	34.48	62.08
Lead-zinc	276	.04	7.21	----------	4.88	25.09	47.73
	750,631	.13	4.46	14.03	3.98	.71	54.18

Crude ore of all kinds shipped directly to the smelters amounted to nearly 5 per cent of the total output and produced 31 per cent of the gold, 76 per cent of the silver, 3 per cent of the copper, 69 per cent of the lead, and 7 per cent of the zinc. The corresponding percentages in 1922 were 36, 75, 7, 69, and 9.

Mine production of gold, silver, copper, lead, and zinc from Utah crude ore shipped to smelters in 1923

By counties

County	Ore	Gold	Silver	Copper	Lead	Recoverable zinc	Total value
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
Beaver	4,933	225.05	53,718	26,575	1,350,397	137,441	$156,482
Box Elder	2,154	435.38	217,534	22,533	41,077	----------	193,565
Iron	30	----------	33	83	13,922	----------	1,014
Juab	241,430	23,146.49	5,701,541	2,417,984	41,973,743	338,359	8,470,358
Piute	2,608	1,744.73	49,223	10,235	456,443	----------	109,886
Salt Lake	114,723	7,200.05	902,207	2,415,424	24,889,246	84,616	2,991,716
Sevier	14	14.60	60	34	----------	----------	356
Summit	58,648	2,500.34	2,244,288	778,229	25,578,060	----------	3,796,867
Tooele	18,205	1,024.58	107,318	73,833	3,206,057	96,965	351,052
Utah	75,684	3,895.63	2,477,094	489,222	34,261,143	120,854	4,590,161
Wasatch	69,543	5,396.21	2,807,781	456,724	7,787,636	----------	3,026,202
Washington	36	1.13	637	----------	20,693	----------	1,994
	588,008	45,584.19	14,561,434	6,690,876	139,578,417	778,235	23,689,653

By kinds of ore

Dry and siliceous	196,789	24,224.68	4,988,239	2,393,008	3,926,534	----------	$5,217,754
Copper	18,919	2,620.58	53,299	1,205,107	30,852	----------	277,188
Lead	369,650	18,695.46	9,480,853	3,002,400	135,137,196	----------	18,061,726
Zinc	48	----------	56	----------	1,067	28,346	2,049
Copper-lead	969	24.95	30,817	90,361	163,592	----------	50,520
Lead-zinc	1,633	18.52	8,170	----------	319,176	749,889	80,416

Average content

	Short tons	*Fine ounces per ton*	*Fine ounces per ton*	*Per cent*	*Per cent*	*Per cent*	
Dry and siliceous	196,789	0.12	25.35	0.61	1.00	----------	$26.51
Copper:							
Oxidized	1,942	.17	13.41	5.15	.78	----------	30.66
Sulphide	16,977	.14	1.61	2.96	.02	----------	12.82
Lead:							
Oxidized	175,934	.05	27.46	.30	21.11	----------	54.01
Sulphide	193,716	.05	24.01	.50	15.71	----------	44.19
Zinc: Oxidized	48	----------	1.17	----------	1.11	29.53	42.69
Copper-lead: Oxidized	969	.03	31.80	4.66	8.44	----------	52.14
Lead-zinc:							
Oxidized	273	.01	2.23	----------	6.82	25.80	46.77
Sulphide	1,360	.01	5.56	----------	10.37	22.39	49.74
	588,008	.08	24.76	.57	11.87	.07	40.29

GOLD

The mine production of gold increased 34 per cent, and ores mined in Salt Lake, Juab, and Piute counties, named in order of output, produced most of it.

Gold produced in Utah is largely a by-product in the smelting of the copper and lead ores and concentrates. The Utah Copper property, at Bingham, was the largest producer of gold in 1923; the

Grand Central property, in the Tintic district, was second; and the Utah Consolidated, Deer Trail, United States, Niagara, Chief Consolidated, and Park-Utah mines followed.

SILVER

In 1923 Utah was the largest producer of silver in the United States, and the output increased 11 per cent. Juab County again led in output, followed by Utah, Wasatch, Summit, and Salt Lake counties. The increase was especially noticeable in the Park City and Tintic districts.

Cyanidation of gold and silver ores was reported by only one operator, and only a little ore was treated by amalgamation. Leaching mills using a chloridizing-roasting process recovered rich precipitates and silver bullion, from which 1,106,317 ounces of silver was reported in 1923.

Ten properties each produced more than 500,000 ounces of silver in 1923. The Tintic Standard, in the Tintic district, ranked first, with an output of 3,614,295 ounces, followed by the Chief Consolidated (exclusive of Gemini, Grand Central, and Eureka Hill production), in the Tintic district; the Park-Utah, Silver King Coalition, and Judge mines, in the Park City region; the Vipont Silver, in Box Elder County; the Grand Central, in the Tintic district; the Utah Copper, at Bingham; the Victoria, in the Tintic district; and the Daly West, at Park City.

COPPER

The largest quantity of copper in 1923 was produced from ores mined in the Bingham or West Mountain district, Salt Lake County, followed by the Tintic district, Juab County, and the Park City region, Summit and Wasatch counties.

Crude ore shipped to smelters contained 6,690,876 pounds of copper, against 6,517,059 pounds in 1922; of the copper from crude copper ore smelted, 1,005,250 pounds was derived from sulphide ores and 199,857 pounds from oxidized ores; of the lead ores smelted, sulphide ores yielded 1,953,838 pounds of copper and oxidized ores 1,048,562 pounds. The dry and siliceous ores, used principally for fluxing at smelting plants, contained 2,393,008 pounds, against 2,106,925 pounds in 1922. The low-grade disseminated ores concentrated contained 208,354,907 pounds of copper, against 88,098,018 pounds in 1922.

The leading producers of copper, named in order of production, were the Utah Copper Co. (reporting 195,142,919 net pounds),[2] Utah Consolidated, Ohio Copper, Tintic Standard, Park Utah, Silver King Coalition, and Grand Central mines. The Ohio Copper Co., at Lark, continued the work of leaching in place the caved area of the mine, which is said to carry 6 to 8 pounds of copper to the ton.

LEAD

An increase of 50 per cent in the output of lead was due to the better price paid for the metal and to the general improvement in market conditions.

[2] Utah Copper Co. Nineteenth Ann. Rept., for year ending Dec. 31, 1923.

The Bingham or West Mountain district produced 50,705,666 pounds, compared with 38,695,793 pounds in 1922. The greatest part of the production at Bingham came from the Utah Apex and United States mines. The Park City region produced 52,440,692 pounds, against 32,257,593 pounds in 1922; the Tintic district produced 77,812,795 pounds, against 47,291,192 pounds; the combined production of the Ophir and Rush Valley districts, Tooele County, increased from 7,013,845 to 9,454,661 pounds; and the output in Beaver County increased from 2,375,746 to 3,471,858 pounds.

First rank in the output of lead was taken by the Tintic Standard property, in the eastern part of the Tintic district, which was followed in order by the Silver King Coalition, in the Park City region; the Chief Consolidated, in the Tintic district; the Utah Apex, at Bingham; the property of the United States Mining Co., at Bingham; and the Judge mine, at Park City. Each of these was credited with producing more than 12,000,000 pounds of lead. The next in rank were the Daly West, Ophir Hill, Victoria, Niagara, Dalton & Lark, Cardiff, Eagle & Blue Bell, and Keystone mines.

ZINC

The zinc oxide plant of the Utah Zinc Co., near Murray, was idle in 1923, but the remaining stock of zinc oxide made in 1922 was sold.

MINING INDUSTRY

Producers of silver in Utah made a strenuous effort to mine as much ore as possible before the termination of purchase under the Pittman Act, in June, 1923. The increase was general among the large producing districts but was especially large in the Tintic district. These efforts, coupled with the high price of lead, which in many localities carries silver as a by-product, maintained the output of silver at a slightly higher level than in 1922. The lead-smelting plants at Murray, Midvale, and International were operated continuously, having at one time 16 lead furnaces in blast. A gradual lessening of lead-smelter output followed the rush to get silver ores to the lead plants. At both Murray and Midvale one furnace out of six was shut down. At the Garfield copper plant three copper reverberatory furnaces were in operation continuously and four the last part of the year.

Beginning March 16 there was a general wage increase in Utah of 7.5 to 15 per cent, with a maximum of 50 cents a day. Miners received $5.25 a shift, and muckers $4.75. When these increases went into effect copper-mining companies in Utah were expanding their operations on a climbing copper market, but later in the year the price declined to around 12 cents a pound, compared with 16.85 cents a pound in March, and in consequence wages were reduced 50 cents a shift November 1.

The Union Pacific Railroad Co. connected Lund, on the Salt Lake Route, with Cedar City, in Iron County, thereby giving an outlet to the iron ore and gypsum, of which large deposits are being opened.

In September the initial shipment of iron ore was made from Iron Springs by the Columbia Steel Corporation. This shipment marked the birth of the steel industry in Utah.

REVIEW BY COUNTIES

Mine production of gold, silver, copper, lead, and zinc in Utah in 1923

County	Gold					Silver	
	Placers		Deep mines		Total value	Fine ounces	Value
	Fine ounces	Value	Fine ounces	Value			
Beaver			721.46	$14,914	$14,914	133,428	$109,411
Box Elder			1,967.99	40,682	40,682	776,326	636,587
Grand	10.40	$215			215	2	2
Iron						33	27
Juab			23,220.15	480,003	480,003	5,788,396	4,746,485
Piute			7,866.89	162,623	162,623	122,763	100,666
Salt Lake			100,085.17	2,068,944	2,068,944	2,414,780	1,980,119
San Juan			6.72	139	139	2	2
Sevier			14.80	306	306	72	59
Summit			3,616.03	74,750	74,750	2,790,770	2,288,431
Tooele			1,143.20	23,632	23,632	478,033	391,987
Uintah	15.09	312			312	1	1
Utah			4,204.32	86,911	86,911	3,466,310	2,842,374
Wasatch			5,951.53	123,029	123,029	3,165,917	2,596,052
Washington			1.11	23	23	637	522
	25.49	527	148,799.37	3,075,956	3,076,483	19,137,470	15,692,725

County	Copper		Lead		Recoverable zinc		Total value
	Pounds	Value	Pounds	Value	Pounds	Value	
Beaver	92,850	$13,649	3,471,858	$243,030	156,372	$10,633	$391,637
Box Elder	30,579	4,495	181,941	12,736			694,500
Grand							217
Iron	83	12	13,922	975			1,014
Juab	2,458,706	361,430	41,995,534	2,939,687	338,359	23,008	8,550,613
Piute	23,524	3,458	785,411	54,979			321,726
Salt Lake	216,384,633	31,808,541	58,417,679	4,089,238	3,161,085	214,954	40,161,796
San Juan							141
Sevier	34	5					370
Summit	954,985	140,383	38,915,514	2,724,086	42,752	2,907	5,230,557
Tooele	1,000,562	147,083	9,874,472	691,213	96,965	6,594	1,260,509
Uintah							313
Utah	718,174	105,571	36,245,591	2,537,191	120,854	8,218	5,580,265
Wasatch	729,442	107,228	13,525,178	946,762	7,414,526	504,188	4,277,259
Washington			20,693	1,449			1,994
	222,393,572	32,691,855	203,447,793	14,241,346	11,330,913	770,502	66,472,911

Ore sold or treated, number of deep mines producing, and value of ores in Utah in 1922 and 1923

County	Ore sold or treated, 1923 (short tons)		Number of deep mines producing		Average total value per ton[a]		Average value per ton in gold and silver	
	Total	Increase or decrease	1922	1923	1922	1923	1922	1923
Beaver	17,275	+5,684	7	14	$22.72	$22.67	$10.87	$7.20
Box Elder	31,861	−33,505	4	4	17.50	21.80	16.91	21.26
Grand	----------	−10	1	----------	52.20	----------	40.20	----------
Iron	30	+25	2	1	74.00	33.80	10.20	.90
Juab	251,641	+4,731	36	31	36.47	33.98	27.44	20.77
Piute	16,909	−21,473	4	4	19.89	19.03	17.39	15.57
Salt Lake	11,850,327	+7,086,909	43	42	3.79	3.39	.60	.34
San Juan	10	+10	----------	1	----------	14.10	----------	14.10
Sevier	15	+8	1	2	13.57	24.67	13.57	24.33
Summit	249,119	+77,527	12	10	21.63	21.00	13.74	9.49
Tooele	78,021	+20,791	21	23	14.77	16.16	6.13	5.33
Utah	153,551	+33,532	11	11	24.64	36.34	18.79	19.08
Wasatch	104,203	+18,715	4	2	42.96	41.05	35.76	26.09
Washington	36	+20	1	1	30.87	55.39	30.87	15.14
	12,752,998	+7,192,964	147	146	7.27	5.21	3.52	1.47

[a] Value per ton, placer product excluded.

BEAVER COUNTY

Mine production of gold, silver, copper, lead, and zinc in Beaver County, Utah, in 1923

	Number of producers	Ore	Gold	Silver	Copper	Lead	Recoverable zinc	Total value
		Short tons		*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
1923	14	17,275	$14,914	133,428	92,850	3,471,858	156,372	$391,637
Increase from 1922	7	5,684	3,839	18,552	46,080	1,096,112	149,997	128,343
Total, 1860–1923	----------	----------	882,686	22,319,156	53,027,724	432,734,514	36,233,521	53,097,496

Beaver Lake district.—Small lots of first-class shipping ore were produced from the O. K., Galena, and Beaver Copper properties amounting to 42 tons, which contained principally copper and lead. The Beaver Copper and Galena properties were under development.

Lincoln district.—Considerable ore was shipped from the Croff property, the larger part of which was lead ore containing a little silver and copper. Two lots of oxidized zinc ore were also sold.

Rocky district.—The property of the Milford Copper Co. was closed in November. Considerable ore has been mined from the Montreal claim during the last two years, which was valuable chiefly for fluxing, as it contained an average of 51 per cent of iron. The quantity of ore produced and its contents are not taken into account in the totals of this report, as the ore averaged less than 0.1 per cent of copper.

San Francisco district (*Frisco, Newhouse*).—The Horn Silver mine, for years the largest producer in the San Francisco district, was operated by lessees, who mined first-class ore and shipped old tailing. Some sulphide zinc-lead ore is included in the output. At

the Quad Metals mine the 100-ton concentration plant was operated by a lessee, and several lots of lead ore and concentrate were shipped to the smelter.

Star and North Star district.—The output of 1,062 tons of ore reported by seven producers in the Star district contained gold, silver, copper, and lead valued at $26,138, or $24.61 a ton. The Moscow and Wild Bill properties were the principal producers of lead. Smaller lots of ore were shipped from the Lady Bryan, Saint Croix, Humboldt, and Harrington-Hickory mines.

BOX ELDER COUNTY

Ashbrook district.—The mine and mill of the Vipont Silver Mining Co. were operated until August, but production on a large scale ceased June 1, when purchases of silver under the Pittman Act were stopped. The ore was treated by flotation, and the concentrates contained principally silver, with a little gold, lead, and copper. The mine was the sixth largest producer of silver in Utah. The concentrate is hauled 28 miles to Oakley, Idaho, on the Oregon Short Line Railroad.

Lucin district.—Lessees operated the Copper Mountain property of the Salt Lake Copper Co. and shipped copper ore with a little lead ore to the smelter.

Park Valley district.—The Susannah mine, which is being developed by the Gold Quartz Leasing Co., recovered a little gold bullion in the course of experimental work.

Rosebud Creek district.—A small lot of lead ore containing silver was mined about 12 miles northwest of Watercress, on the Southern Pacific Railroad.

GRAND COUNTY

A placer property near Moab, in the Colorado River district, was worked by the Metals Extraction Co., and a small quantity of gold bullion was sold.

IRON COUNTY

Calumet district.—The Coin Silver Mines Co. shipped to the smelter about 50 tons of ore, containing 24 per cent of lead and no silver.

Iron Springs district.—Considerable interest was attached to the opening of the iron-ore deposit of the Columbia Steel Corporation in the Iron Springs district. Shipments of iron ore for flux at lead smelters near Salt Lake City were made at a railroad rate approximating $1.75 a ton. A steam shovel was placed on the Milner iron deposit, which is to supply fluxing ore to lead smelters when railroad facilities are provided.

JUAB COUNTY

Fish Springs district.—Lessees mined first-class ore from the Carnation and Galena properties and milled ore from the dump of the Utah mine, from which silver-lead concentrate was recovered.

Mount Nebo district.—Ore containing 22 per cent of zinc, 18 per cent of lead, and 16 ounces of silver to the ton was shipped from the

Eva mine by lessees. At the Nebo Star property lead ore containing a little silver was produced.

Spring Creek district.—From the Premier Silver mine several lots of silver ore containing lead, some of which was very high grade, were hauled 25 miles to Gold Hill, a station on a branch of the Western Pacific Railroad. The work done by lessees suggests that the property may become a regular producer.

Tintic district.—The eastern part of the Tintic district lies in Utah County, but a number of important mines in that part are included in this review and in the table for the district.

Mine production of gold, silver, copper, lead, and zinc in Tintic district, Utah, 1922–23

County	Year	Number of producers	Ore	Gold	Silver	Copper	Lead	Recoverable zinc	Total value
			Short tons		*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
Juab	1922	29	246,232	$435,092	6,323,713	1,810,804	35,878,517	24,022	$8,977,951
	1923	23	250,279	475,300	5,773,233	2,456,434	41,658,463	318,891	8,508,223
Utah	1922	6	119,480	30,229	2,210,241	484,315	11,412,675		2,933,550
	1923	8	151,691	56,044	3,458,727	576,122	36,154,332		5,507,693
Total	1922	35	365,712	465,321	8,533,954	2,295,119	47,291,192	24,022	11,911,501
	1923	31	401,970	531,344	9,231,960	3,032,556	77,812,795	318,891	14,015,916
Total, 1869–1923				35,759,551	170,961,011	191,214,521	1,009,824,700	17,685,901	249,325,995

Total dividends, 1869–1923, $38,649,410.

The values of the metals for 1923 are as follows: Gold, $531,344, against $465,321 in 1922; silver, $7,570,207, against $8,533,954; copper, $445,786, against $309,841; lead, $5,446,895, against $2,601,016; zinc, $21,684, against $1,369. The ore sold or treated in the district in 1923 averaged $34.87 a ton, compared with $32.57 in 1922.

Mine production of gold, silver, copper, lead, and zinc in Tintic district, Utah, in 1923, by kinds of ore

Kind of ore	Number of producers	Ore	Gold	Silver	Copper	Lead	Recoverable zinc
		Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Dry and siliceous	22	197,259	14,857.45	3,382,404	2,008,025	4,092,674	
Copper	3	1,754	320.41	25,280	169,425	29,302	
Lead	22	202,178	10,520.90	5,819,176	855,106	73,545,557	
Zinc	1	15				555	8,298
Lead-zinc	2	764	5.00	5,100		144,707	310,593
		401,970	25,703.76	9,231,960	3,032,556	77,812,795	318,891

The Chief Consolidated Co.[3] not only owns several developed mines—the Grand Central, Gemini, Ridge & Valley, and Eureka Hill—but has a controlling ownership of six other mines only partly developed. At the lime quarry of the company a complete hydrating

[3] Chief Consolidated Mining Co. Fifteenth Ann. Rept., for year ending Dec. 31, 1923.

plant was constructed and put in operation. The hydrated lime is said to be of excellent quality and is finding a good market at sugar plants. Some of the product was sold to a manufacturer of calcium arsenate. The company (including the output of all mines controlled) is the largest producer of silver in Utah and is third in the output of lead. Dividends amounted to $356,479.80 in 1923, or a total of $2,670,105.07 since 1913. The combined output of all the properties was greater in quantity of ore and in all metals except silver than in any previous year, as shown in the company's annual report.

Ore and metals produced by Chief Consolidated Co. in 1923 and 1909–1923

Year	Ore	Gold	Silver	Lead	Copper	Zinc	Net returns	
							From smelter	After charges
	Dry tons	*Ounces*	*Ounces*	*Pounds*	*Pounds*	*Pounds*		
1923	134,312	13,145	4,025,792	26,498,897	1,068,597	367,958	$3,363,934	$786,964
1909–1923[a]	897,346	83,957	26,716,974	134,315,578	2,424,182	2,769,237	[b] 20,276,817	[b] 5,160,461

[a] The production of the Chief Consolidated mine by years is given in Mineral Resources, 1918, pt. 1, p. 388.

[b] Includes returns on 360,716 pounds of manganese in 1918.

Of the ore produced, the Chief mine contributed 72,235 tons of silver-lead ore, 20,347 tons of dry and siliceous ore, and 672 tons of zinc-lead ore; the Grand Central mine 5,942 tons of silver-lead ore and 22,966 tons of dry and siliceous ore; the Gemini mine 8,672 tons of silver-lead ore, 335 tons of dry and siliceous ore, and 92 tons of zinc-lead ore; and the Eureka Hill mine 2,465 tons of silver-lead ore and 586 tons of dry and siliceous ore. The ore from the Chief mine averaged 0.0521 ounce of gold and 32.9 ounces of silver to the ton, 15.68 per cent of lead in lead ore, 1.17 per cent of copper in copper ore, 13.82 per cent of lead in zinc-lead ore, and 24.16 per cent of zinc in zinc-lead ore and had a total value of $47.49 a ton. After deducting charges for smelting, freight, and sampling, the net value was $27.96 a ton. The ore from the Grand Central mine averaged 0.2422 ounce of gold and 20.71 ounces of silver to the ton, 8.47 per cent of lead, and 3.58 per cent of copper. It had a gross value of $29.14 a ton and a net value of $16.45 a ton. The Gemini ore averaged 30.59 ounces of silver to the ton, 11.63 per cent of lead in lead ore, 1.55 per cent of copper in copper ore, 11.60 per cent of lead in zinc-lead ore, and 23.69 per cent of zinc in zinc-lead ore. The gross value of all ore was $43.40 a ton, and the net value $23.43 a ton. The Eureka Hill ore, assaying 0.0363 ounce of gold and 14.91 ounces of silver to the ton, 12.43 per cent of lead, and 4.23 per cent of copper, was valued at $28.06 gross and $11.25 net a ton.

A newly discovered process for the treatment of ore from the Chief Consolidated mines has warranted the company in building a mill, the first unit of which was completed in 1924. Considerable experimental work involving concentration and volatilization has been under way for some time. No ore was shipped to the Tintic Milling Co. Development in all the mines of the Chief Consolidated Co. amounted to 53,410 feet. At the Chief mine ore was

produced and development work done in the first zone from the 1,400-foot level to the 2,050-foot level, and in the second zone from the 1,400-foot to the 2,130-foot level. A winze in the limestone is expected to be completed to the 2,200-foot level in January, 1925, and development of that level commenced. At the Grand Central mine production was made and development work done on all levels from the 600-foot to the 2,200-foot. A drift on the 2,300-foot level and a winze below develop the extension of the Centennial channel. At the Gemini mine development work on the 1,900-foot level is encouraging. The upper levels of the mine produced a little ore, but most of the output was mined below the 1,600-foot level. In the Plutus four sets of lessees mined ore through the 1,300-foot level of the Grand Central mine. At the Eureka Hill mine eight sets of lessees were mining ore from the 100-foot level to the 900-foot level. In many places in the Chief and Gemini mines deep-hole drilling led to the quick discovery of ore. This method of work is particularly valuable in prospecting, according to the report of the company, which continues as follows:

> In our mines there has been recently developed a system of deep-hole drilling with the ordinary standard hammer drills that has been found to work very great economy in the search for and finding of the ore channels, and more particularly their innumerable offshoots so common in this class of mineralization. By an ingenious and effective connecting device for the drill rods, it has been found possible to carry the drilling to depths of several hundred feet at any angle and from the usual underground openings. The adoption of this system permits of the search being made with the drills, and the driving of the drifts, crosscuts, winzes, or raises only when ore has been found, and will effect a large saving in the cost of this class of work and also will materially facilitate and speed up the development of additional working places in ore. This has particular application to our mines and in our work, because of our realization of the necessity of doing a larger proportion of development work than is common, we believe, in general mining practice, and this as rapidly as possible.

An annual statement published by the Tintic Standard Mining Co. shows that the ore produced in 1923, containing gold, silver, copper, and lead, was valued at $4,476,899.40, which, with the products from the milling ore, gave a total value of $5,462,669.24. The total output of ore was 139,050 dry tons, of which 60,873 tons was lead ore, containing 1,963.90 ounces of gold, 1,901,071 ounces of silver, 33,582,906 pounds of lead, and 332,027 pounds of copper. Siliceous silver ore amounted to 6,898 tons, containing 212.62 ounces of gold, 464,883 ounces of silver, 314,957 pounds of lead, and 72,258 pounds of copper. The milling ore, of which 71,280 tons was treated, contained 2,122.89 ounces of gold, 1,248,340 ounces of silver, 6,691,167 pounds of lead, and 526,968 pounds of copper. Dividends paid in 1923 amounted to $581,750, making a total of $2,352,605. The Tintic Standard mine produced several carloads of high-grade silver ore. One lot of 59 tons of ore assayed 1,016 ounces of silver and netted $64,727 at the smelter.

Work in the Eagle & Blue Bell mine[4] was confined to mining the known ore shoots, which continued to supply most of the output. Altogether 19,492 dry tons of ore, which includes 3,308 tons mined by lessees, was produced in 1923. Of the company ore pro-

[4] Eagle & Blue Bell Mining Co. Ann. Rept. for year ending Dec. 31, 1923.

duced, 8,961 tons was mixed carbonate and sulphide lead ore, containing 274 ounces of gold, 133,426 ounces of silver, and 1,820,856 pounds of lead, valued in all at $209,742. The net smelter returns on this ore amounted to $112,539. Siliceous ore, of which 6,139 tons was mined, contained 334.42 ounces of gold, 126,414 ounces of silver, 193,439 pounds of lead, and 35,030 pounds of copper, valued in all at $112,390, or at $56,716 after freight and treatment charges were deducted. The dump ore, of which 1,084 tons was shipped, contained 102 ounces of gold, 10,930 ounces of silver, 3,670 pounds of lead, and 6,295 pounds of copper, valued in all at $8,674 gross or $2,646 net. The mine is opened by a vertical shaft 2,000 feet deep and was operated continuously during 1923. Total dividends paid since 1913 amounted to $1,761,283.90, including $89,314.60 in 1923.

The Victoria mine[5] produced 22,742 tons of ore, of which 16,507 tons was lead ore, containing 805.54 ounces of gold, 450,216 ounces of silver, 5,404,334 pounds of lead, and 2,288 pounds of copper, valued in all at $625,514. After all charges for freight, smelting, sampling, and assaying were deducted, the net smelter returns amounted to $434,713. The dry and siliceous ore amounted to 6,234 dry tons, containing 646.04 ounces of gold, 102,776 ounces of silver, 94,861 pounds of lead, and 26,439 pounds of copper, valued in all at $96,167 gross or $45,952 net. The 1,450–1,350 series of stopes on the Victoria zone continued to furnish most of the output. These ore bodies have shown remarkable continuity in their upward extension, both in size and value.

From the American Star mine[5] 3,099 dry tons of ore was produced, of which 2,557 tons was dry and siliceous ore and 542 tons was ore from the dump. The dry ore contained 161.62 ounces of gold, 54,051 ounces of silver, and 24,988 pounds of copper, valued in all at $46,715, for which the net smelter return was $25,478. The dump ore contained 35.79 ounces of gold, 4,859 ounces of silver, and 4,056 pounds of copper, valued in all at $3,662 gross or $828 net. Interesting developments in the American Star mine are reviewed in the company's report as follows:

> The ore zone strikes north-south, approximately paralleling the important ore channels of Tintic, and possesses the same characteristics. The ore has proved continuous for 390 feet and in two different places widens out to 65 and 120 feet, respectively. While most of it is low-grade, occasional shipments of high-grade are made. In January a lot of 61 dry tons assayed 0.085 ounce of gold, 55.8 ounces of silver, and 1.01 per cent of copper; and another in September of 68 dry tons carried 0.12 ounce of gold, 59 ounces of silver, and 0.9 per cent of copper.
>
> Operations were carried on through the 1,875 raise, driven to prospect the north end of the ground, until the increased development necessitated better operating facilities.

The Iron Blossom mine[6] produced about 15,000 tons of ore that sold for $285,835.83. About one-third of this ore containing silver was treated by the Tintic Milling Co. at Silver City, and the rest was shipped to smelters. A new ore body was opened about 110 feet east of the old ore channel, was explored a distance of 1,000 feet on its strike, and was found to be from 7 to 20 feet wide. The ore

[5] Bingham Mines Co. Fifteenth Ann. Rept., for year ending Dec. 31, 1923.
[6] Iron Blossom Consolidated Mining Co. Ann. Rept. for year ending Dec. 31, 1923.

of this body contains bismuth as well as other metals, and several lots contained sufficient bismuth to be paid for by the smelting company. Copper ore was mined from the 800-foot level of the No. 1 shaft, and lessees mined copper ore from the 1,100-foot level. The Iron Blossom mine is worked entirely under the leasing system, but profits were sufficient to pay $100,000 in dividends.

In the course of prospect work lessees working along the old ore channel of the Colorado mine[8] shipped 8,531 tons of ore, most of which was low-grade material containing about 8 ounces of silver to the ton and a little gold. This low-grade ore was treated by the Tintic Milling Co. at Silver City. About 700 tons of low-grade ore from the waste dump contained silver and lead, which was recovered in concentrate in the testing plant of the Eureka Metallurgical Co. near Murray, Utah. About 800 tons of the higher-grade lead-silver ore was sold to the smelter at Midvale. Altogether these ore sales amounted to $56,505, according to the annual statement of the company.

The Dragon mine[9] produced 22,460 tons of iron ore for flux, which sold for $68,725, and some siliceous silver ore, valued at $9,851, which was treated by the Tintic Milling Co. at Silver City. At the north end of the Dragon property a raise was driven 30 feet from the main tunnel level to explore the formation that was so productive at the south end of the Iron Blossom property. As a result of this development work considerable lead-silver ore was opened. Several car lots of kaolinized gouge having the quality of fuller's earth were shipped to the Dutch Shell Co. for oil filtration.

The Centennial Eureka mine and the Bullion Beck & Champion property were both operated by lessees and produced a small amount of lead ore. Some exploration work was done, for the most part by the lessees, but without any discoveries of importance.

The Little May mine, 2 miles west of Silver City, in the course of development work produced 190 tons of sulphide ore, for which $2,037 was received. The ore containing silver and copper was sold to the Tintic Milling Co., and two car lots of lead-silver ore containing a little copper were shipped to lead smelters.

Silver ores containing oxidized minerals of lead are subjected to a chloridizing roast at two plants of the Tintic Standard and Tintic Milling companies in the Tintic district. The lead is recovered from the ore, together with the silver, by the use of brine. Because of the oxidized condition of the Tintic Standard ore, mechanical concentration is not efficient, and leaching has been adopted, the Holt-Dern process as developed in the mill of the Tintic Milling Co. at Silver City being used. The Tintic Standard mill ore averages 0.025 ounce of gold and 17 ounces of silver to the ton, 0.35 per cent of copper, 4 per cent of lead, 56 per cent of silica, 16.3 per cent of iron and aluminum, 0.33 per cent of lime, 0.12 per cent of zinc, and 2.5 per cent of sulphur. About 200 tons of this ore is treated daily by pulverizing, mixing with coal dust and salt, and roasting in a roaster of the Holt-Dern type. This chloridized ore is then placed in

[8] Colorado Consolidated Mines Co. Ann. Rept. for year ending Dec. 31, 1923.
[9] Dragon Consolidated Mining Co. Ann. Rept. for year ending Dec. 31, 1923.

wooden leaching vats and treated with a strong brine, which dissolves the silver, copper, gold, and lead. This method of ore treatment is described in a recent paper.[10]

Eleven mines shipped low-grade silver ore up to the end of August to the custom plant of the Tintic Milling Co. at Silver City. During the time that silver sold for $1 an ounce this company made a small margin of profit on the ores treated, but after the cessation of the Pittman Act it closed its plant.

West Tintic district.—Several lots of oxidized lead ore from the Imperial lead mine were shipped to the smelter by way of Lucerne, on the Salt Lake Route of the Union Pacific system. Lessees operating the old Scotia property shipped ore containing 8 to 12 per cent of lead and 5 to 6 ounces of silver and about $5 in gold to the ton.

MORGAN COUNTY

A small lot of iron ore, carrying 48 per cent of iron and valuable chiefly as a flux in smelting, was shipped from the property of the Morgan Copper & Iron Co., in the Hardscrabble district.

PIUTE COUNTY

Mount Baldy district.—The Deer Trail mine and mill, at Marysvale, were operated only part of the year. Considerable ore was mined and treated by cyanidation and concentration. Cyanide precipitates containing gold and silver were shipped to Omaha, Nebr., and lead concentrate, with some crude ore, was shipped to the smelter at Midvale, Utah. The mine was a large producer of gold and the only one in Utah at which cyanidation was used.

Ohio district.—One lot of concentrate was shipped from ore treated in the Bully Boy mill, but the mine and plant were closed indefinitely late in 1923. From the Tushar Range Metals property a small lot of gold ore, yielding $152 in gold and 5 ounces of silver to the ton, was shipped to the smelter. The Valdasia claim also produced a little gold ore.

SALT LAKE COUNTY

Big and Little Cottonwood districts.—In the Big Cottonwood district nine producers reported the output of 6,133 tons of ore, containing $596 in gold, 135,204 ounces of silver, 64,230 pounds of copper, and 3,694,229 pounds of lead, valued in all at $379,501, or $61.88 a ton. Most of this output was lead ore from the Cardiff mine. Small lots of lead ore were shipped from the Howell, Prince of Wales, and Woodlawn properties.

In the Little Cottonwood district five producers reported 12,541 tons of ore, containing $3,678 in gold, 229,151 ounces of silver, 280,323 pounds of copper, and 3,968,703 pounds of lead, valued in all at $510,599, or $40.71 a ton.

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[10] Ralston, O. C., Hydrometallurgy of lead: Am. Inst. Min. and Met. Eng. Bull. 1281–M, December, 1923; Min. Jour. (London), Jan. 19, 1924, p. 54.

Mine production of gold, silver, copper, lead, and zinc in Big Cottonwood and Little Cottonwood mining districts, Utah, in 1923

	Number of producers	Ore	Gold	Silver	Copper	Lead	Recoverable zinc	Total value
		Short tons		*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
1923	14	18,674	$4,274	364,355	344,553	7,662,932	-------	$890,100
Increase or decrease from 1922	-------	+1,215	−1,495	+69,878	−411,442	+2,154,799	-------	+184,847
Total, 1867–1923	-------	555,265	542,392	15,327,310	14,450,782	214,610,951	322,055	31,014,940

The principal producers of ore in the Little Cottonwood district were the Columbus Rexall, Michigan-Utah, Alta Merger, Wasatch Mines, and Emma Silver properties. The Alta Merger Mines Co. is a consolidation of several properties at Alta with the South Hecla mine, which has been a conspicuous producer since 1914. Both the Columbus Rexall and the Michigan-Utah mines produced more than 4,000 tons of lead ore containing silver, but the output of the Wasatch Mines was decidedly less than in recent years.

The Skipper and Gold Ore Zone veins of the Alta Merger Mines Co.[11] produced 445 tons of ore, containing 22.11 ounces of gold, 9,914 ounces of silver, 4,839 pounds of copper, and 85,720 pounds of lead. The net smelter returns on this ore amounted to $10,323, which included the payment for some bismuth in the ore. About 1,400 acres, covering 99 mining claims and fractions of claims, includes the properties formerly operated by 24 mining companies as follows: Alta & Hecla, Lilborn, Bingham Centennial, Greely, Albion, Alta Germania, Jack, Alta Quincy, Ivanhoe, Albion Consolidated, Ben Harrison, Rustler, South Hecla Mining, South Columbus, Columbus Wedge, South Columbus Consolidated, South Hecla Extension, Alta Utah, Emerald, Sells, K. P. Mining, Mineral Flat Mining, South Hecla Mines, and Alta Michigan.

Lead ore was opened in the West Toledo property by an upraise 757 feet vertically above the level of the Frederick tunnel. The raise was started 2,500 feet from the portal of the adit. The ore occurs in a bedded deposit cut by several fissures. The bed, which is about 12 feet thick, strikes northwest and dips 40° NE. The fissures stand nearly vertical and strike northeast. Two of the fissures carry lead ore of good grade. The bedded deposit was mined along its strike for 85 feet, with ore continuing in the northwest end. Cross-section samples for 60 feet of the bed assayed 41 per cent of lead and 0.2 ounce of silver to the ton, and 10 feet of the bed averaged 23 per cent of lead and 0.1 ounce of silver. No ore was shipped in 1923.

Smelter district.—Ore from car and track cleanings and old tailings in the Smelter district amounted to 1,814 tons. Concentrate from the old tailings, which were estimated at 1,700 tons, came from previous mill operations near Midvale.

Bingham or West Mountain district.—The average value of the ore produced in the Bingham district in 1923 was $3.32 a ton, against

[11] Alta Merger Mines Co. Ann. Rept. for year ending Dec. 31, 1923.

$3.66 in 1922. The shipments of ore to the smelters amounted to 96,039 tons, against 104,840 tons in 1922; the output of concentrating ore was 11,733,680 tons, against 4,639,779 tons; and the quantity of concentrates produced was 678,919 tons, against 265,719 tons. Ore of smelting grade, amounting to 96,039 tons, consisted of low-grade copper and lead sulphides and contained 6,986.11 ounces of gold, 535,491 ounces of silver, 2,069,552 pounds of copper, 17,218,960 pounds of lead, and 84,616 pounds of zinc, valued in all at $2,098,824, or $21.85 a ton. Milling ores, of which there were 11,733,680 short tons, yielded 678,919 tons of copper, lead, zinc, and lead-zinc concentrates that contained 92,866.09 ounces of gold, 1,510,468 ounces of silver, 209,236,872 pounds of copper, 33,486,706 pounds of lead, and 2,999,679 pounds of recoverable zinc, valued in all at $36,461,164, or $53.70 a ton. The total output of the district includes the metallic content of copper precipitates recovered from leaching ore in place, mine waters, and a little slag from an old smelter dump.

Mine production of gold, silver, copper, lead, and zinc in Bingham or West Mountain district, Utah, in 1923

	Number of producers	Ore	Gold	Silver	Copper	Lead	Recoverable zinc	Total value
		Short tons		*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
1923	24	11,829,839	$2,064,141	2,046,071	216,037,146	50,705,666	3,084,295	$39,258,508
Increase or decrease from 1922	−2	+7,084,029	+876,786	+664,772	+124,275,409	+12,009,873	−1,549,291	+21,909,635
Total, 1865–1923			[a]40,024,980	[a]58,452,040	2,433,008,197	1,358,943,377	58,259,256	601,302,159

[a] Includes small placer production.

Total dividends, 1865–1923, $136,523,528.

Ore and metals produced in Bingham district, Utah, in 1923

Source	Number of producers	Ore	Gold	Silver	Copper	Lead	Recoverable zinc
		Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Dry and siliceous ore	4	35,132	3,935.29	122,349	620,241	267,734	
Copper ore	15	11,516,256	82,388.70	834,856	213,958,224	379	
Lead ore	15	147,343	3,647.49	584,605	1,086,695	28,727,264	16,535
Lead-zinc ore	4	131,108	9,881.36	504,261	371,986	21,710,289	3,067,760
		11,829,839	99,852.84	2,046,071	216,037,146	50,705,666	3,084,295

From the Utah Copper property[12] at Bingham 11,167,800 tons of concentrating ore was mined, leaving of the reserves previously reported 347,378,049 tons, averaging approximately 1.35 per cent of copper. Lessees mined 770 tons of crude ore, and 548,610 pounds of copper was produced from the precipitating plants at Bingham. During 1923 the Arthur mill treated 6,508,900 tons of ore, an average of 17,833 tons a day, and the Magna plant treated 4,658,900 tons, an

[12] Utah Copper Co. Nineteenth Ann. Rept., for year ending Dec. 31, 1923.

average of 12,764 tons a day, or a total of 11,167,800 tons, equivalent to a daily average of 30,597 tons.

The average grade of the ore was 1.12 per cent of copper, compared with 1.26 per cent in 1922. The average recovery was 80.96 per cent, corresponding to 18.18 pounds of copper per ton of ore treated, compared with 80 per cent, or 20.13 pounds of copper per ton of ore treated, in 1922. The average cost of mining and concentrating ore, including a proper apportionment of fixed and general charges (but not Federal taxes or depreciation), was 34.38 cents a ton, of which 12.5 cents represented charges for stripping. The actual direct cost of mining all ore was 22.38 cents a ton. The average milling cost was 61 cents a ton, a decrease of 23 cents compared with 1922. The total mining, ore delivery, and milling cost was $1.069 a ton in 1923.

The average cost per net pound of copper produced from all sources, including depreciation of plant and equipment and all fixed and general expenses and crediting gold, silver, and miscellaneous earnings, was 8.735 cents a pound, compared with 8.707 cents in 1922. The value of the gold and silver recovered and the miscellaneous earnings amounted to 1.313 cents a pound of copper, compared with 1.454 cents in 1922.

All the copper concentrate from the Magna and Arthur mills is treated at the Garfield smelter of the American Smelting & Refining Co. The total copper contained in concentrate was 202,986,306 pounds from a concentrate averaging 18.61 per cent. Refined copper produced in 1923 amounted to 195,142,919 pounds, which sold for 14.37 cents a pound, or a total of $28,053,733. The gold produced amounted to 72,548.77 ounces, valued at $20 an ounce, or a total of $1,450,975. Silver amounted to 630,940 ounces, which sold for an average of 75.91 cents an ounce, or a total of $478,944. Altogether the metals brought $29,983,653; the operating expenses were $18,475,032, leaving a profit from operations of $11,508,621. Distribution from capital amounting to $6,497,960 made the total paid to stockholders since payments were begun amount to $125,317,827.50.

From the annual report of the United States Smelting, Refining & Mining Co. for 1923 the following paragraphs are taken:

> Tonnage produced from the Bingham mines, including the Niagara Mining Co., amounted to 141,026 tons of complex zinc-lead ore, 3,457 tons of copper ore, and 7,309 tons of copper-iron concentrates.
>
> Development work has resulted in a material increase in known ore reserves. On December 31 the Butterfield tunnel, which is being driven for the purpose of further developing the lower levels of the property, had reached a distance of 9,837 feet from its portal, and it should be finished some time during the present year. On the average, slightly more miners than in 1922 were on the pay roll, and it is hoped that upon completion of the new boarding house and change house the forces will be further increased, making it possible to extract a materially greater tonnage and expedite development work.

Operations in the Dalton & Lark mines[13] during 1923 proved the continuity and productiveness of the several ore bodies. Lead ore amounting to 4,157 tons, for which $78,569 was paid by the smelter, was mined from the Lark vein in the workings known as the winze 4 west, the Mascotte east drift, the 1,100-foot level of the Revere claim, and the Lead mine. Copper ore amounting to 11,914 tons,

[13] Bingham Mines Co. Fifteenth Ann. Rept., for year ending Dec. 31, 1923.

for which the smelter paid $45,705, was mined from the Brooklyn vein, Lark vein, and Lead mine. In addition to this ore output, the Lead mine produced 2,006 tons of dry and siliceous ore, for which the smelter paid $15,925. The company's output was as follows:

Mine production of gold, silver, lead, and copper by Dalton & Lark mines, Bingham district, Utah, in 1923

Kind of ore	Ore	Gold	Silver	Lead	Copper	Gross value	Smelter returns
	Dry tons	*Ounces*	*Ounces*	*Pounds*	*Pounds*		
Lead ore	4,156.62	83.95	36,698.20	1,644,152	142,555	$111,636.72	$78,569.00
Copper ore	11,914.40	715.15	46,286.73		248,004	63,855.16	45,705.37
Dry ore	2,006.30	354.67	29,392.40	13,644	3,852	30,215.80	15,925.40
	[a] 18,077.32	1,153.77	112,377.33	1,657,796	394,411	205,707.68	140,199.77
Company and lease ore produced, 1909–1923		24,910	2,928,762	44,566,491	9,723,520		

[a] Exclusive of 5,486.23 dry tons of ore mined by lessees, on which the company received as royalty the sum of $38,572.50.

No development work was done on the Commercial or Yosemite properties. One carload of lease ore, on which the royalty amounted to $75.32, was shipped from the Yosemite.

From the Mayflower vein of the Montana-Bingham property[14] 9,460 tons of ore was shipped, netting at the smelter $60,925. Most of the ore (9,318 tons) was copper ore, containing 633.68 ounces of gold, 14,892 ounces of silver, and 566,148 pounds of copper. In addition to the copper ore, 26 tons of lead ore, averaging 30 per cent of lead, 1.43 per cent of copper, and 0.045 ounce of gold and 9.30 ounces of silver to the ton, was shipped. Two carloads amounting to 115 tons of sulphide iron ore shipped averaged 0.04 ounce of gold and 0.4 ounce of silver to the ton, 0.6 per cent of copper, about 40 per cent of sulphur, and 30 per cent of iron. An adjoining property, the Tiewaukee, was partly paid for in 1923, and mine development work started.

The Utah Apex mine[15] shipped 54,961 tons of ore and milled 73,810 tons, from which 19,698 tons of concentrate was recovered. The total ore and concentrate shipped to the smelter contained 2,569 ounces of gold, 402,908 ounces of silver, 22,661,749 pounds of lead, 1,393,006 pounds of copper, and 9,592,399 pounds of zinc. The proceeds from the sale of ore after deducting smelter charges amounted to $1,216,105.57. On June 15 a dividend amounting to $264,100 was paid to stockholders.

Ore sales by the Utah Metal & Tunnel Co.[16] amounted to $32,111 from the output of about 750 tons of crude ore and 500 tons of lead concentrate. Another source of income, amounting to $26,676, was the water from springs on the Middle Canyon side of the mountain supplied to the Utah Copper Co.

Probably the first and most successful attempt toward leaching low-grade copper ore in place was made at the Ohio Copper property[17] in 1923. Altogether 3,819,417 pounds of copper was re-

[14] Montana-Bingham Consolidated Mining Co. Ann. Rept. for year ending Dec. 31, 1923.
[15] Utah Apex Mining Co. Ann. Rept. for year ending Aug. 31, 1923.
[16] Utah Metal & Tunnel Co. financial statement for year ending Dec. 31, 1923.
[17] Ohio Copper Co. Ann. Rept. for year ending Dec. 31, 1923.

covered at a cost of 6.82 cents a pound and sold for 13.735 cents a pound. The total operating profit amounted to $264,080.87. The caved area, from which the copper has been recovered, has a surface of 840,000 square feet, and of this area a plot not more than 2,500 square feet was percolated. According to Boutwell,[18] the original upper Carboniferous limestone and sandstone beds at Bingham were fractured by a quartz monzonite intrusion which silicified the sandstone beds to quartzite and shattered the surrounding rock. The richest ore deposits, which were in the limestone, have been mined, and it is the disseminated deposit in the monzonite and quartzite that constitutes the present ore bodies. The quartz monzonite disintegrates readily, owing to the alteration of its minerals, thus becoming porous and allowing its minerals to be exposed to oxidation. The shattered quartzite, in comparison, is practically inert to chemical attack, but the copper minerals that are deposited in the fissures are subject to chemical alteration. Microscopic determinations show that the copper disseminated in the quartzite is to some extent due to resilicification. The quartz monzonite might furnish alteration products that would clog the ore body. The quartzite would furnish none. As the Ohio Copper ore body occurs at the contact of the original sandstone beds with the monzonite, the amount of monzonite present is not large, and there is but little danger of clogging. These findings are contained in a paper[19] which describes the method of operation and percolation of copper as follows:

> About 400 gallons of water a minute are now being pumped from Bingham Canyon over the top of the caved area, and about 300 gallons are collected in the Mascotte tunnel by drainage from various properties. The equipment for handling is of the simplest kind. A 4-inch pump directly connected to a 60-horsepower motor raises the water about 300 feet to launders over the caved area now located near the southern boundary of the property. These launders are about 150 feet in length and are made by nailing three 2 by 12 inch planks together so as to make a trough. The water is more or less distributed through 2-inch holes in both sides of the launder.
>
> The solution then percolates down through 1,400 feet of caved area, enriching itself in copper until its arrival at the Mascotte tunnel, where it is run into the solution launders as explained. * * *
>
> It has been feared that the solutions might channel in going through the stopes and thus dissolve but little copper. The point had also been brought up that excessive solution loss due to leakage might also result. The peculiar shape of the ore body and the fact that its footwall has a talcose slickenside prevents excessive loss of solutions by leakage. That the solution does not follow channels is shown by the fact that a shift of only 10 feet in the launders at the surface causes a slackening in the flow of the solution arriving at the Mascotte tunnel for a period about as long as it takes the solution to go through the stopes. When this new solution arrives at the Mascotte tunnel its copper content is the same as the solution had after the lapse of a similar period of time when it was cycled before. Since this very small shift in launder spacing causes these results, it may be seen that the solution follows independent channels. But little sediment arrives at the Mascotte tunnel, which may be settled out, and this arrives only during the first half hour after the water which has been drained from a new area on the surface has reached the tunnel level. There is but little danger, then, of the ore body plugging, due to decomposition products from the rocks. The only other danger that might arise and cause plugging of the ore body would come from the precipitation of basic iron salts, and this matter will be gone into experimentally at some length. Such a possibility could only be shown

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[18] Boutwell, J. M., Economic geology of the Bingham mining district, Utah: U. S. Geol. Survey Prof. Paper 38, pp. 162–167, 1905.

[19] Varley, Thomas, and Oldright, G. L., Leaching of caved areas, Ohio Copper mine, Bingham Canyon, Utah (paper read by permission of the Director, U. S. Bureau of Mines, at Utah Metal Mining Institute, Salt Lake City, May 5, 1923).

after a long period of operation or considerable experimental work along lines following the actual conditions as they exist in the mine. As long as simple water solutions are used there will be comparative freedom from the trouble along this line, but should it become necessary to reuse the tailing water from the iron boxes in the Mascotte tunnel the necessity for acidulation would arise. The reuse of this water has been considered because it is difficult to remove the last trace of copper from solution. The iron in the solution, on oxidizing, furnishes an excellent solvent for oxidized copper in the ore body which would otherwise not be attacked by a simple water solution, particularly in areas furnishing no pyrite to make acid in place. The open nature of the entire workings makes it possible to add acid at any place in the circuit and to modify the solution in such ways as experience may prove necessary.

Launders have been placed on either side of the 2½-foot gage track of the electrified mine railway in the Mascotte tunnel. A total of 3,200 lineal feet of launder 32½ inches by 32½ inches in internal cross section have been installed, and about 1,400 feet of launder outside the tunnel are in use. The launders are built of 2-inch by 12-inch lumber and are of conventional design except that solution crossovers and gates are installed at intervals so that the liquor may be shunted to the one side or the other when it may be desired to remove the copper from a given section. There is a false bottom in the launders about a foot below the solution level so that the copper precipitated may collect beneath this grating. Loosely baled tinned scrap reject from the canning factories was first used, but they are now using detinned scrap from the Pacific coast, as the tin causes the copper to adhere too closely. About 1 pound of iron is consumed per pound of copper precipitated. Although the cost of the scrap is high, about $19 a ton f. o. b. Lark, the smaller quantity of iron needed, the saving in labor, and the cleaner cement copper produced makes its use advisable.

The product has an excellent red color and is very high grade for cement copper, the February shipment running 92.06 per cent copper. The product is shoveled into mine cars between the launders and is screened to remove any unused iron which may be in the precipitate. Other constituents of the cement copper are (about) sulphur, 2.24 per cent; iron, 2.9 per cent; insoluble, 2 per cent; lead, 0.12 per cent; and there is some combined water.

The problems that have arisen in connection with the precipitation of the copper have been as follows: In the head boxes the copper has adhered tightly to the iron, thus diminishing the capacity. Experiments are now contemplated to determine the relationship between the adherence of the copper and the solution content in copper, acid, ferrous and ferric iron. The difficulties in removing the last traces of copper from solution are well known. Calculations are now being made to determine whether it will be better to add more launders or to recirculate the exit liquors from the iron boxes. As any soluble copper in the exit solutions is lost, serious consideration is to be given to these features.

At the Highland Boy and Yampa mines operations were continued throughout 1923, resulting in the production of about 300,000 tons of low-grade copper ore and 7,000 tons of crude lead ore. This ore was transported over the 4-mile aerial tramway of the company to International, where the copper ore was concentrated and the concentrate and the lead ore were reduced at the International smelter. The suit brought by the Utah Apex Co. was decided adversely to the Utah Consolidated Co.[20] by the United States Circuit Court of Appeals on December 4, 1922. On February 26, 1923, the Supreme Court refused to review the case, and a judgment of nearly $1,300,000 was entered against the Utah Consolidated Co. To raise this amount a loan was obtained from the International Smelting Co. In its annual report the Utah Consolidated has given the cause for the suit as follows:

In the Bingham district, in which your company's properties are located, is a belt or stratum of limestone approximately 200 feet in thickness, which

[20] Utah Consolidated Mining Co. Ann. Rept. for year ending Dec. 31, 1923.

courses through the district in a generally east and west direction. Before the controversy between your company and the Utah Apex Co. arose, this stratum of limestone had been the subject of litigation in three separate cases, and the decisions of the courts in these cases were uniformly that the owner of the apex or outcrop of this limestone was entitled to follow it (for the length to which the apex or outcrop extended within his mining claims) to the greatest depths and was entitled to the ownership of all ore bodies found therein. The portion of this limestone bed which outcrops within the claims of your company passes in depth beneath the surface of the Utah Apex Co. Within this stratum of limestone the Utah Consolidated discovered and for several years mined certain ore bodies, a portion of which finally extended beneath the surface of the Utah Apex. It was this portion which was the subject of litigation.

Under the general mining law, and more specifically under the above referred to decisions, which had been applied to other portions of this same limestone belt, your company believed itself without question the owner of this ore and that in addition it was entitled to follow this limestone bed to still further depths and to the ownership of any other ore bodies which might be found within the bed irrespective of the ownership of the surface beneath which they occurred.

Other producers were the Starless, United Bingham, Congor, Queen (Lavagnino), Utah Boston Development, Bingham Coalition, New York-Bingham, Ute Copper, and small producers of copper precipitates recovered from mine waters and old tailings.

SAN JUAN COUNTY

At the head of Johnson Creek, in the Blue Mountain district, a little development work was done at the Gold Dream property. From these operations a small quantity of gold was recovered in experimental work. The milling plant of five stamps has a daily capacity of 20 tons and is equipped to treat ore by amalgamation, concentration, and cyanidation.

SEVIER COUNTY

Henry district.—From the Royal Purple mine crude ore containing gold and a little bullion were sold, though the output was probably from previous operations.

Monroe district.—One lot of gold ore was shipped to the smelter from the White Oak claim, on Birch Creek, 6 miles south of Monroe.

SUMMIT AND WASATCH COUNTIES

The Uinta district, in Summit County, and the Blue Ledge and Snake Creek districts, in Wasatch County, represented the producing area of the Park City region in 1923.

Mine production of gold, silver, copper, lead, and zinc in Park City mining region, Utah, in 1923

	Number of producers	Ore	Gold	Silver	Copper	Lead	Recoverable zinc	Total value
		Short tons		*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
1923	12	353,322	$197,779	5,956,687	1,684,427	52,440,692	7,457,278	$9,507,816
Increase or decrease from 1922	−4	+96,242	+28,686	+711,493	+241,572	+20,183,099	+7,457,278	+2,124,577
Total, 1870–1923			5,043,915	155,879,572	37,794,642	1,426,197,833	81,801,398	203,946,622

Total dividends, 1870–1923, $48,006,092.

Mine production of gold, silver, copper, lead, and zinc in Park City region, Utah, in 1923, by kinds of ore

Kind of ore	Number of producers	Ore	Gold	Silver	Copper	Lead	Recoverable zinc
		Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Dry and siliceous	2	54,674	4,859.29	2,339,871	169,582	1,236,097	----------
Lead	10	193,693	4,135.27	3,279,290	1,237,416	45,257,783	----------
Lead-zinc	2	104,955	573.00	337,526	277,429	5,946,812	7,457,278
	-------	353,322	9,567.56	5,956,687	1,684,427	52,440,692	7,457,278

From the Silver King Coalition mine[21] 105,046 tons of ore was mined at a cost of $512,228, or $4.87 a ton. To hoist and haul this ore cost $105,802, or $1.01 a ton; the total extraction cost was therefore $5.88 a ton. Of the total ore mined, 72,661 tons was milled and produced 4,293 tons of iron middlings and 11,737 tons of lead concentrate, which cost to produce $108,876.80, or $1.498 a ton. The sampling cost of 48,848 tons of ore, middlings, and concentrate was 26.6 cents a ton, and the aerial-tramway cost 31.4 cents a ton. Of the ore sampled, 32,385 dry tons was shipped directly to the smelter with 433 tons of lease ore and the iron middlings and lead concentrate mentioned above. The average contents of all products mentioned above are given in the following table:

Gold, silver, copper, and lead produced by Silver King Coalition mine, Utah, in 1923

Kind of material	Gold		Silver		Lead		Copper		Net smelter returns
	Per ton	Total	Per ton	Total	Percentage	Total	Percentage	Total	
	Ounces	*Ounces*	*Ounces*	*Ounces*		*Pounds*		*Pounds*	
First-class ore	0.056	1,640.14	42.21	1,367,274	28.37	18,381,214	1.00	645,855	$1,745,942
Lead concentrate	.059	597.40	27.12	318,371	33.45	7,851,304	.39	91,818	553,526
Iron concentrate	.032	135.41	12.09	51,980	7.14	612,670	.32	27,351	52,893
Lessees' ore	.100	43.44	45.06	19,510	32.04	277,666	.72	6,226	[a] 9,008
	--------	2,416.39	--------	1,757,135	-------	27,122,854	------	771,250	2,361,369

[a] Sold for $28,417.77.

Development cost in 1923 for drifting, raising, and sinking averaged $11.048 a foot. The output of ore was increased the first six months to take advantage of the high price of silver before the expiration of the Pittman Act, and development work was therefore curtailed. During the last half of 1923 the development of the property disclosed new ore deposits. All the new mill operations were successful in making a high recovery, and with an additional flotation unit to be in operation by May, 1924, the company expected to save the zinc content of the ore. A stock pile of 2,600 tons of middlings, containing zinc, iron, silver, and lead, is not included in the above totals but awaits treatment at the new mill unit under

[21] Silver King Coalition Mines Co. Ann. Rept. for year ending Dec. 31, 1923.

construction. Dividends paid to stockholders amounted to $851,270, which made the total disbursements to the end of 1923 $16,597,075.

Control of the Silver King Consolidated mines and 17,000-foot adit was purchased in May, 1924, by the Silver King Coalition Mines Co., which now owns and controls about 3,800 acres of mineral ground. According to the annual report of the Silver King Consolidated Mining Co. for 1923, its main adit was extended several hundred feet into the California-Comstock group, and considerable prospecting was done in the so-called iron workings above the adit level. The levels of the old King Consolidated mine were cleaned out, and the leasing system introduced. Prospect work was also done from a point in the Spiro tunnel 11,800 feet from the portal. A crosscut was driven southeast through the black lime for 400 feet, where it passed through a fault into underlying gray limestone. Other developments in this part of the property, though promising, were without profit. The ore shipped from the King Consolidated workings amounted to 58 tons, which contained 4.99 ounces of gold, 3,520 ounces of silver, 2,046 pounds of copper, and 41,205 pounds of lead, valued in all at $4,141.60. Including the 1923 output, the Silver King Consolidated mine has produced in ten years of its existence 52,047 dry tons of ore, valued at $2,426,268, and paid dividends to stockholders amounting to $1,562,705. Of this amount, $308,791 was derived from a judgment paid by a cotenant.

The Park City Mining & Smelting Co.[22] sold 57,419 tons of ore and concentrate, for which $1,816,085.97 was received. The crude ore (33,139 tons) averaged 0.031 ounce of gold and 31.61 ounces of silver to the ton, 17.68 per cent of lead, and 1.14 per cent of copper, and sold for $31.54 a ton. The milling ore from which concentrate was produced amounted to 50,718 tons. Lead concentrate, of which 13,562 tons was shipped, contained an average of 0.037 ounce of gold and 22.38 ounces of silver to the ton, 30.57 per cent of lead, and 0.95 per cent of copper and sold for $41.47 a ton. Zinc concentrate amounted to 10,720 tons and contained 0.015 ounce of gold and 8.80 ounces of silver to the ton, 3.72 per cent of lead, 0.54 per cent of copper, and 41.53 per cent of zinc and sold for $19.44 a ton. Dividends paid to stockholders amounted to $459,900.

Ore produced from the Park-Utah mine[23] amounted to 49,659 dry tons and was sold for $1,425,008.32, or $28.70 a ton. This ore contained 4,868.46 ounces of gold, 2,221,330 ounces of silver, 1,277,493 pounds of lead, and 199,337 pounds of copper. Dividends paid to stockholders amounted to $600,000, making a total since production began of $1,146,036.75. Expenditures charged to the mine account amounted to $319,504.60, sampling and assaying $34,821.51, hauling $81,106.28, prospecting and dead work $259,757.95, general expense $150,108.12, and construction $72,416.72. The branch line of the Union Pacific Railroad to the portal of the Ontario drain tunnel was about completed in December. On completion of this branch the output of ore from the Park-Utah mine is expected to be doubled. Development of the Park-Utah mine is confined to a vertical shaft sunk to develop the lower levels and has reached a point halfway between the 1,700 and 1,800 levels. An inclined

[22] Park City Mining & Smelting Co. Financial statement for year ending Dec. 31, 1923.
[23] Park-Utah Mining Co. Financial statement for year ending Dec. 31. 1923.

winze sunk in the hanging wall of the ore deposit reached the 1,700-foot level in December, and although the work was still in the hanging wall high-grade ore was opened up.

The Ontario Silver Mining Co. was reorganized, and the controlling interest, with a four-sevenths interest in the Weber coal mine and in the Ontario drain tunnel, was transferred. Included in the transfer is the control of the Naildriver mine and a substantial interest in the Keystone mine. This transaction completed the formation under one control of a compact group of claims on the Ontario fissure system from the Park-Utah mine on the east through the Ontario, Daly, old Daly West, Daly-Judge, and West Ontario mines. The Park City Mining & Smelting Co. interests dominate this part of the district. The Ontario lode was discovered in 1872, and from January, 1877, to the end of 1922, according to a company report.[24] the mine has produced from 934,242 tons of ore 44,395,427 ounces of silver, 6,793 ounces of gold, and 10,030,858 pounds of lead. Dividends paid to stockholders from 1877 to 1919 amounted to $14,157,500. In 1923, the mine produced about 9,000 tons of ore containing principally silver with a little gold, lead, and copper.

The Keystone mine and mill were operated from January to April, considerable lead ore was concentrated, and the concentrate with crude lead ore was shipped to the smelter. No shipments were made between July and December 1.

TOOELE COUNTY

Mine production of gold, silver, copper, lead, and zinc in Tooele County, Utah, in 1923

	Number of producers	Ore	Gold	Silver	Copper	Lead	Recoverable zinc	Total value
		Short tons		*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
1923	23	78,021	$23,632	478,033	1,000,562	9,874,472	96,965	$1,260,509
Increase from 1922	2	20,791	13,808	136,845	223,643	2,837,956	53,014	415,100

Clifton district (Gold Hill).—The output of 13,237 tons of ore from six properties in the Clifton district represented a marked increase over the output of 1922. Most of the ore shipped from Gold Hill was more valuable for its arsenic than for the gold, silver, copper, and lead which it also contained, though in small quantities. The total value of these metals was $76,836, or $5.80 a ton, but it was estimated that more than 7,000,000 pounds of metallic arsenic was contained in the ores shipped in 1923. The arsenic was paid for as arsenious oxide at the rate of 3.5 to 4 cents a pound, and the principal producer was the Gold Hill property of the Western Utah Copper Co. Several small lots of lead ore were shipped from the Herat and New Baltimore claims, copper-lead ore from the Mineral Hill, and one lot of copper ore from the Last Dollar group. Three lots of remarkably rich gold ore were shipped from the Rube mine,

[24] Ontario Silver Mining Co. Statement for listing stock on New York Exchange, Mar. 10, 1924.

one car of which averaged 24.42 ounces of gold and 6.88 ounces of silver to the ton, 2.85 per cent of lead, and 15 per cent of iron.

Columbia district.—The old Sharp mine was operated by lessees and produced lead ore containing a little silver, which was hauled 12 miles to Dunbar, on the Salt Lake Route of the Union Pacific system.

Lakeside district.—Lead ore of shipping grade from the Monarch mine was hauled to Delle, a station on the Western Pacific Railroad.

Ophir district.—Ten producers in the Ophir district reported the output of 60,585 tons of ore, containing $2,897 in gold, 387,528 ounces of silver, 943,476 pounds of copper, 6,886,989 pounds of lead, and 96,965 pounds of recoverable zinc, valued in all at $948,044, or $15.65 a ton. Most of the ore was milled and produced lead concentrate containing copper and silver, and only 769 tons was of shipping grade. The first-class ore included some oxidized zinc ore shipped to an eastern smelter. The Ophir Hill mine and mill were operated continuously, and other properties producing ore were the Three Metals, Kearsarge, Queen of the Hills, Ophir, Hidden Treasure, Jim Fiske, Buffalo Consolidated, Magnolia, and Mono claims.

Rush Valley district (Stockton).—The property of the Bullion Coalition Mines Co. was operated by lessees, and 935 tons of ore of smelting grade was produced. The New Stockton Mining Co. produced a little lead ore, and the Keystone Development Co., operating the Galena King mine, reported a considerable output of lead ore containing silver and a little gold.

Silver Islet district.—First-class copper-lead ore containing considerable silver was mined and shipped to the smelter from the Silver Lake property.

Willow Springs district.—Silver ore containing a little copper and lead was shipped to the smelter from the Wonder claim, 10 miles west of Callao.

UNITAH COUNTY

About 400 yards of gravel was handled at the Horse Shoe placer, in the Green River district, in making tests with a Ferguson concentrator. A little bullion was produced but not sold.

UTAH COUNTY

American Fork district.—Three producers in the American Fork district reported the output of 1,860 tons of ore, of which 1,395 tons was of shipping grade and 465 tons was treated in a concentration mill and yielded copper concentrate containing considerable gold. The total output was valued at $72,572, or $39.02 a ton. During the summer and fall of 1923 shipments of ore were made at the rate of two or three cars each week. This ore came principally from the Silver Wave property, in Mary Ellen Gulch, operated by the American Leasing Co., which also works the Live Yankee and Bellerophon mines. The Silver Wave ore deposit had an average width of 20 feet and a thickness of 12 feet. The New Mary Ellen, lying northeast of the Silver Wave property, and the Globe mine are under development. One lot of sulphide lead ore and some zinc ore was shipped from the Dutchman mine. The Pittsburg property produced similar ore, which was carried by aerial tramway to the flat

below the mine and hauled by wagon to the railroad. At the Pacific mine development was continued by two miners, who in December opened up 4 inches of galena about 1,430 feet from the portal of the tunnel and 500 feet from the surface.

Mine production of gold, silver, copper, lead, and zinc in American Fork district, Utah, in 1923

	Number of producers	Ore	Gold	Silver	Copper	Lead	Recoverable zinc	Total value
		Short tons		*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
1923	3	1,860	$30,867	7,583	142,052	91,259	120,854	$72,572
Increase or decrease from 1922	−2	+1,321	+23,941	+277	+110,971	−13,370	+120,854	+48,389
Total, 1870–1923		78,911	315,173	1,941,042	366,317	30,294,628	167,765	4,148,990

Tintic district.—In the eastern part of the Tintic district, in Utah County, the Tintic Standard, Colorado Consolidated, Sioux, Crown Point, Iron King, May Day, Uncle Sam, and Yankee properties made a considerable production of ore, which is included in the output of the Tintic district under Juab County.

WASHINGTON COUNTY

The Paymaster property, in the West Mountains, 18 miles west of St. George, in the Tutsagubet district, produced a small quantity of silver-lead ore, which was hauled 25 miles by wagon and 60 miles by autotruck to the railroad.

WEBER COUNTY

A small lot of ore containing 36 per cent of iron and 43 per cent of silica was shipped as iron flux from the Willard district to a lead smelter near Salt Lake City.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN MONTANA

(MINE REPORT)

By C. N. Gerry[1]

PRODUCTION

GENERAL FEATURES

The value of the mine production of gold, silver, copper, lead, and zinc in Montana in 1923 was nearly 29 per cent greater than that of 1922. Though it did not reach the average of the last decade, which was more than $74,000,000, it was about the same as the average just before the World War. Silver Bow County, which includes the Butte or Summit Valley district, continued to produce most of the silver, copper, lead, and zinc, but most of the gold was mined in other districts. Published reports show that dividends amounting to $9,590,198 were paid by the Anaconda Copper Mining Co., the Butte & Superior Mining Co., and the Butte Copper & Zinc Co.

Mine production of gold, silver, copper, lead, and zinc in Montana in 1923

	Number of producers	Ore	Gold [a]	Silver [a]	Copper	Lead	Recoverable zinc	Total value
		Short tons		*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
1923	382	5,743,535	$1,758,748	13,380,862	224,125,264	35,945,623	141,460,392	$57,812,970
Increase or decrease from 1922	−11	+1,357,657	+101,991	+912,711	+58,370,822	+6,178,144	+22,390,574	+12,887,021

[a] Includes placer production.

Tables published in Mineral Resources for 1922 gave the production of Montana from 1911 to 1922 separated by kinds of ore. The gold, which has decreased nearly 53 per cent since 1911, came chiefly from dry and siliceous ore, and the remainder largely from placers and copper ore. The output of silver, which is not decreasing, came chiefly from copper ore and in part from zinc, lead-zinc, and siliceous ores. The output of lead from lead ore was relatively small, the most of it coming from zinc ore and lead-zinc ore combined.

[1] Valuable assistance, especially in the compilation of the statistical tables of this report, was given by B. N. Lowry, of the U. S. Geological Survey.

ORE

The quantity of ore sold or treated in Montana in 1923 was nearly 31 per cent more than that of 1922, but the average value decreased from $10.23 a ton to $10.06. Of the total ore, 71 per cent was concentrated, 3 per cent was treated in gold and silver mills, and 3 per cent was shipped directly to smelters. The remainder, nearly 23 per cent, consisted of slag, which was resmelted, and old tailings, which were concentrated or cyanided.

Mines in Silver Bow County produced nearly 92 per cent of the total ore. The dry and siliceous ore was principally gold ore and silver ore. The gold ore included much iron ore containing gold from Deer Lodge and Broadwater counties, which was used at the smelters for fluxing. Copper ore amounted to nearly 77 per cent of the total ore mined, and zinc ore to 9 per cent. The quantities of different kinds of first-class shipping ore and concentrates with their contents are given in the tables on pages 455–456. Copper ore and copper concentrates exceeded all other kinds, and most of the first-class ore was sulphide.

Ore and metals produced in Montana in 1923

Source	Number of producers	Ore		Gold		Silver	
		Short tons	Per cent	Fine ounces	Per cent	Fine ounces	Per cent
Dry gold ore	78	217,307	3.78	48,277.86	56.75	63,358	0.47
Dry gold and silver ore	7	275		394.11	.46	8,342	.06
Dry silver ore	90	124,671	2.17	6,071.84	7.14	1,208,535	9.03
Copper ore	37	4,420,601	76.97	19,776.67	23.24	7,619,864	56.95
Lead ore	90	105,450	1.84	2,368.15	2.78	437,703	3.27
Zinc ore	3	540,738	9.42	3,019.08	3.55	2,119,593	15.84
Copper-lead ore	5	106,325	1.85	271.05	.32	340.559	2.55
Lead-zinc ore	16	228,168	3.97	2,927.99	3.44	1,582,548	11.83
Total deep mines		5,743,535	100.00	83,106.75	97.68	13,380,502	100.00
Total placers	78			1,972.68	2.32	360	
		5,743,535	100.00	85,079.43	100.00	13,380,862	100.00
Increase from 1922		1,357,657		4,933.81		912,711	

Source	Copper		Lead		Zinc	
	Pounds	Per cent	Pounds	Per cent	Pounds	Per cent
Dry gold ore	8,579		4,910	0.02		
Dry gold and silver ore	126		1,588			
Dry silver ore	41,566	0.02	36,369	.10		
Copper ore	220,471,500	98.37	1,864			
Lead ore	184,842	.08	8,741,531	24.32	69,560	0.05
Zinc ore	1,494,440	.67	11,069,586	30.80	106,426,645	75.23
Copper-lead ore	598,152	.27	1,445,059	4.02		
Lead-zinc ore	1,326,059	.59	14,644,716	40.74	34,964,187	24.72
	224,125,264	100.00	35,945,623	100.00	141,460,392	100.00
Increase from 1922	58,370,822		6,178,144		22,390,574	

GOLD ORE

The gold ore, largely dry and siliceous, was mined by 78 producers in 1923, compared with 77 in 1922. This ore averaged $4.59 in gold and 0.29 ounce of silver to the ton, with a little copper and lead,

and was valued at $4.84 a ton. Phillips, Park, Lewis and Clark, Jefferson, and Deer Lodge counties produced most of the gold ore, and the Ruby Gulch mine, at Zortman, was the largest producer.

Content of dry gold ore sold or treated in Montana in 1923

County	Ore	Gold	Silver	Copper	Lead
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Beaverhead	34	161.84	44		
Broadwater	5,436	887.66	108	6,087	856
Deer Lodge	14,008	2,014.13	1		
Fergus	100	124.09	131		
Granite	269	446.24	437	330	169
Jefferson	23,587	6,245.95	863	332	1,236
Lewis and Clark	29,278	15,288.97	23,688	187	77
Madison	4,651	2,169.50	3,817	809	2,408
Meagher	16	53.62	6		
Mineral	20	14.54	4		
Missoula	400	254.59	69		
Park	44,429	8,048.11	995		
Phillips	95,040	12,530.25	32,991		
Powell	13	8.31	16		164
Ravalli	4	4.50	2		
Silver Bow	22	25.56	186	834	
	217,307	48,277.86	63,358	8,579	4,910

GOLD AND SILVER ORE

Gold and silver ore was mined in six counties by seven producers. The average of the output was $29.62 in gold and 30.33 ounces of silver to the ton, 0.01 per cent of copper, and 0.29 per cent of lead. The Minnie Jane mine, at Butte, was a new producer of this class of ore.

Content of dry gold and silver ore sold or treated in Montana in 1923

County	Ore	Gold	Silver	Copper	Lead
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Broadwater	1	1.10	28		77
Jefferson	13	4.69	127		
Lewis and Clark	1	.60	12		4
Madison	29	25.11	607	47	
Powell	23	30.30	1,048		1,507
Silver Bow	208	332.31	6,520	79	
	275	394.11	8,342	126	1,588

SILVER ORE

The output of siliceous silver ore was mined by 90 producers and averaged $1.01 in gold and 9.69 ounces of silver to the ton, 0.02 per cent of copper, and 0.01 per cent of lead. A marked decrease was shown in this class of ore, especially from mines at Butte. Some of the large producers of silver ore were the Champion mine, in Deer Lodge County; the Elkhorn dump, in Jefferson County; and the Anaconda, Goldsmith, Elm Orlu, and Davis Daly (Hibernia) properties, in Silver Bow County.

Content of dry silver ore sold or treated in Montana in 1923

County	Ore	Gold	Silver	Copper	Lead
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Beaverhead	55	1.23	3,755	156	
Broadwater	1	.07	19		
Cascade	1,401	172.71	85,596		3,486
Deer Lodge	23,524	687.30	231,645		
Fergus	21	1.70	1,100		
Granite	5,953	526.73	273,682	4,523	24,042
Jefferson	18,493	260.59	70,915	3,708	7,116
Lewis and Clark	68	1.44	2,896		922
Madison	183	55.31	9,663	94	640
Phillips	125	8.57	670		
Powell	12	1.22	135	407	
Sanders	10	.11	334		163
Silver Bow	74,825	4,354.86	528,125	32,678	
	124,671	6,071.84	1,208,535	41,566	36,369

COPPER ORE

Copper ore from 37 producers represented nearly 77 per cent of the total ore output. The average content of copper ore was 9 cents in gold, 1.72 ounces of silver, and 49.87 pounds of copper to the ton, and the average value was $8.84. Nearly all the copper ore was mined at Butte, largely from the Anaconda, North Butte, Davis Daly, East Butte, and Butte & Superior properties.

Content of copper ore sold or treated in Montana in 1923

County	Ore	Gold	Silver	Copper	Lead
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Beaverhead	22	0.38	46	2,818	
Broadwater	19	.12	5	7,787	
Granite	853	7.13	2,703	169,950	
Jefferson	82	3.19	284	9,666	
Lewis and Clark	138	13.67	796	44,960	1,864
Madison	49	8.81	462	9,169	
Meagher	50		5	11,381	
Mineral	25	1.90	30	2,300	
Sanders	43	.64	1,319	17,622	
Silver Bow	4,419,320	19,740.83	7,614,214	220,195,847	
	4,420,601	19,776.67	7,619,864	220,471,500	1,864

LEAD ORE

The output of lead ore by 90 producers was valued at $1,046,949. The average content was 46 cents in gold and 4.15 ounces of silver to the ton, 0.09 per cent of copper, 4.14 per cent of lead, and 0.03 per cent of zinc. The total average value of all the metals was $9.93 a ton. Lincoln, Beaverhead, Judith Basin, Broadwater, Lewis and Clark, and Cascade counties produced most of the lead ore, and the Snow Storm, Hecla slag dump, Block P., Lukens Hazel, and Boston-Montana mines were large producers.

Content of lead ore sold or treated in Montana in 1923

County	Ore	Gold	Silver	Copper	Lead
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Beaverhead	25,899	172.02	53,189	133,490	2,106,766
Broadwater	5,996	47.22	18,434	1,475	632,348
Cascade	3,397	112.92	143,487	2,074	475,252
Deer Lodge	29	.14	881	606	6,859
Granite	570	18.30	8,657	216	113,331
Jefferson	2,363	266.30	22,920	19,491	329,352
Judith Basin	16,973	223.90	88,147	4,430	1,691,611
Lewis and Clark	3,710	96.88	22,376	10,908	740,673
Lincoln	44,982	468.96	59,845	6,942	2,264,016
Madison	746	326.82	3,659	3,139	207,901
Meagher	51		61	1,395	9,217
Mineral	19		925		11,595
Missoula	21		163		9,016
Park	117	1.50	3,943	182	31,529
Powell	535	630.00	10,435	395	84,009
Sanders	19	1.18	101		14,882
Silver Bow	23	2.01	480	99	13,174
	105,450	2,368.15	437,703	184,842	8,741,531

COPPER-LEAD ORE

The output of copper-lead ore was reported by five producers. The average content was 5 cents in gold and 3.20 ounces of silver to the ton, 0.28 per cent of copper, and 0.68 per cent of lead, and the average value was $4.46 a ton. Nearly all the output was mill ore from the Silver Dyke property, in Cascade County.

Content of copper-lead ore sold or treated in Montana in 1923

County	Ore	Gold	Silver	Copper	Lead
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Beaverhead	210	10.25	13,842	15,143	105,030
Cascade	106,076	251.10	325,937	580,601	1,328,566
Granite	26	8.60	498	1,480	8,115
Missoula	13	1.10	282	928	3,348
	106,325	271.05	340,559	598,152	1,445,059

LEAD-ZINC ORE AND ZINC ORE

Lead-zinc ore, which represented nearly 4 per cent of the total output of ore, was mined by 16 producers. The average of the output was 27 cents in gold and 6.94 ounces of silver to the ton, 0.29 per cent of copper, 3.21 per cent of lead, and 7.66 per cent of zinc. The total average value was $21.72 a ton. Most of the lead-zinc ore was produced from 10 mines at Butte, and all of it was milled at Butte or Anaconda. The Emma mine, at Butte, was the largest producer.

Content of lead-zinc ore sold or treated in Montana in 1923

County	Ore	Gold	Silver	Copper	Lead	Zinc
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Broadwater	33		280		8,820	14,944
Cascade	65	2.97	337	243	17,150	5,075
Granite	99	1.12	688		13,020	17,595
Jefferson	1,729	173.30	12,807	6,722	182,718	328,712
Missoula	34		93		4,028	11,893
Silver Bow	226,208	2,750.60	1,568,343	1,319,094	14,418,980	34,585,968
	228,168	2,927.99	1,582,548	1,326,059	14,644,716	34,964,187

Zinc ore was mined from three mines in the Summit Valley district, Silver Bow County. The ore contained an average of 12 cents in gold and 3.92 ounces of silver to the ton, 0.14 per cent of copper, 1.02 per cent of lead, and 9.84 per cent of zinc and was valued at $18.55 a ton. The Butte & Superior and Elm Orlu mines were the chief contributors.

GOLD

The output of gold in Montana in 1923 increased more than 6 per cent over that of 1922 but was considerably less than the output of a normal year—in fact, the output has decreased from $5,004,195 in 1915 to $1,758,748 in 1923. Silver Bow County had the largest output, owing to the general activity at Butte, and was followed by Lewis and Clark and Phillips counties. The gold from placer mines decreased decidedly after dredging at Alder Gulch, Madison County, was completed. The increased output from Phillips and Silver Bow counties was due to the work of the Ruby Gulch mine, near Zortman, and the mining of more copper ore at Butte. Nearly 45 per cent of the gold was produced at amalgamation and cyanidation mills, which yielded an average recovery of $3.68 in gold and $0.38 in silver to the ton of ore and tailings treated. About 36 per cent of the gold was contained in concentrates of all kinds, and crude ore shipped to smelters contained 16 per cent of the total. Dry and siliceous ore yielded 64 per cent of the gold, copper ore 23 per cent, placers 2 per cent, lead-zinc ore 3 per cent, zinc ore nearly 4 per cent, lead ore nearly 3 per cent, and copper-lead ore less than 1 per cent. All these sources showed decreases except dry and siliceous ore, copper ore, and zinc ore.

Of the total gold 68 per cent was produced from six properties, of which the copper mines of the Anaconda Copper Mining Co. ranked first. The others were the Ruby Gulch mine, in Phillips County; the Shannon mine, near Marysville; the Jardine mine, in the Sheepeater district, Park County; the Swissmont mine, near Elkhorn, Jefferson County; and the Goldsmith mine at Butte.

SILVER

The silver produced by mines in Montana in 1923 showed an increase of more than 7 per cent in comparison with 1922 and exceeded the yearly average of the last decade, which was 13,000,000 ounces. Most of the silver was obtained from copper ore (nearly

57 per cent) and zinc ore (nearly 16 per cent). Silver Bow County, principally the Butte district, produced 88 per cent of the total. Cyanidation and amalgamation mills produced only a fraction of 1 per cent of the silver, concentrates 87 per cent, crude ore shipped to smelters 11 per cent, and old slag smelted less than 1 per cent.

Twelve properties produced 88 per cent of the silver; each of these produced more than 200,000 ounces, and three of them more than 1,000,000 ounces each—the copper mines of the Anaconda Co., the Butte & Superior, and the Elm Orlu; the other large producers were the Davis Daly, the zinc mines of the Anaconda Co., and the East Butte, Emma, North Butte, Silver Dyke, Goldsmith, and Champion mines. The increase at the Anaconda, Silver Dyke, and Goldsmith mines and in the copper ore from the mines of the Butte & Superior Mining Co. was noteworthy.

COPPER

The mine production of copper in 1923 was 35 per cent greater than in 1922 but was only about 69 per cent of the output of 1918. The large mines were active throughout the year, with the exception of the North Butte and some of the mines of the Anaconda Co.

Silver Bow County, which includes the Butte district, contributed all the copper except 1,082,193 pounds, and copper ore was the source of nearly all the copper. Crude ore of all kinds shipped to smelters contained nearly 5 per cent of the copper and concentrates 92 per cent. The sulphide copper ore of smelting grade contained 10,336,020 pounds, an average content of 3.90 per cent, and the oxidized ore only 213,242 pounds, an average of 11.03 per cent. Slag resmelted and copper precipitates produced from mine waters contained 7,022,993 pounds.

Eight mines in Montana each produced more than 1,000,000 pounds of copper in 1923. The mines of the Anaconda Copper Mining Co. produced more than all others combined, and the other large producers were the North Butte, Davis Daly, Butte & Superior, East Butte, Elm Orlu, and Anselmo mines.

LEAD

The mine production of lead in Montana increased 21 per cent over that of 1922, and nearly 71 per cent of the output was derived from mines in Silver Bow County. Lead-zinc ore was the source of nearly 41 per cent of the lead, zinc ore yielded nearly 31 per cent, lead ore 24 per cent, copper-lead ore 4 per cent, and dry and siliceous ore less than 1 per cent. Crude ore of all kinds shipped to the smelters contained 6 per cent of the total lead, concentrates 87 per cent, and old slag nearly 7 per cent. Most of the first-class lead ore was sulphide.

Nearly all the lead came from 10 properties, which produced more than 1,300,000 pounds each. In the order of output these were the Emma & Ophir, Butte & Superior, Elm Orlu, zinc mines of the Anaconda Co., Snowstorm, Hecla slag dump, Davis Daly, Moulton, Block P., and Silver Dyke mines.

ZINC

The recoverable zinc in the ore mined in Montana in 1923 was nearly 19 per cent greater than that in 1922. At Great Falls the electrolytic zinc plant of the Anaconda Co. was kept in operation,

and much of the zinc ore of Butte was treated there, instead of being shipped, as formerly, to eastern smelters. The Butte & Superior Mining Co., the largest producer of zinc ore, was active throughout the year, though its output of zinc was somewhat less than in 1922. Zinc ore was the source of 75 per cent of the zinc, and lead-zinc ore yielded nearly 25 per cent.

Eight mines at Butte produced nearly all the zinc—the Butte & Superior, Elm Orlu, Emma & Ophir, Anaconda (zinc), Poser, Moulton, Davis Daly, and Anselmo.

MINING INDUSTRY

Though no records of production were broken in Montana in 1923, the mining industry was in a much better condition than in 1922 and 1921. Activity during the first five months of 1923 gave promise of an unusually large metal output. The smelters were active, labor conditions were good, wages were raised at Butte, and metal prices for silver, lead, and zinc were high compared with pre-war prices. Later in the year, however, conditions changed. The price of silver decreased as a result of the cessation of purchases under the Pittman Act, and the price of copper, so important to mine operators in Montana, decreased in October to 12.57 cents a pound, which is close to the cost of production. As a result the North Butte mine was closed in June, wages were reduced in November, and the monthly output of the Anaconda Copper Mining Co. was below normal. Despite high costs and the fact that there was no great demand for copper, the output of silver and copper in 1923 was considerably more than that of any other year since 1918, and a notable increase was made in lead and zinc. The production of gold was sustained by the increase in the mining of copper ore and by the treatment of gold ore in Phillips County, but the Shannon mine, one of the largest producers of gold in Montana, was permanently closed.

METALLURGIC INDUSTRY

Forty-one milling plants of various kinds were active in Montana in 1923, though many of them were operated for only short periods. They included seven plants using the amalgamation process, six using amalgamation and concentration, nine using cyanidation, one using amalgamation and cyanidation, four using table concentration, eight using flotation equipment after table concentration, and two using straight flotation. Three copper-precipitating plants that extracted copper from mine waters and one electrolytic zinc-leaching plant are included in the total.

Of the ore and old tailings treated at gold and silver mills, 62,460 tons was treated by amalgamation, with an average recovery per ton of $2.29 in gold and 0.02 ounce of silver, and 131,173 tons of ore and 20,730 tons of old tailings was treated by cyanidation, with an average recovery per ton of $4.26 in gold and 0.65 ounce of silver. During the year 385 pounds of quicksilver was purchased—0.006 pound per ton of ore amalgamated and 0.046 pound per ounce of bullion recovered—and 274,218 pounds of sodium cyanide was used in gold and silver mills—2.10 pounds per ounce of gold and silver bullion and 1.80 pounds per ton of ore and tailings treated. Nearly 45 per cent more ore was treated by these processes in 1923 than in 1922.

The quantity of gold recovered by cyanidation increased in like ratio, and that recovered by amalgamation showed a smaller increase.

Gold and silver produced at mills in Montana in 1923

County	Ore (short tons)	Bullion (fine ounces) recovered from ore by—				Total value
		Amalgamation		Cyanidation		
		Gold	Silver	Gold	Silver	
Broadwater	13	83.93	37			$1,765
Fergus	100			124.09	131	2,672
Granite	[a] 219	115.76	11	1.35	1,483	3,646
Jefferson	[b] 23,302			[c] 6,213.45	[c] 46,363	166,461
Lewis and Clark	25,656	997.54	488	[d] 12,033.02	[d] 16,123	282,987
Madison	[e] 4,314	883.32	230	357.82	1,335	26,946
Mineral	20	14.54	4			304
Missoula	[f] 400	17.89	1			371
Park	[g] 44,429	4,781.96	654			99,388
Phillips	95,165			12,538.82	33,661	286,802
Powell	11	6.21	3			131
Ravalli	4	4.50	2			95
	193,633	6,905.65	1,430	31,268.55	99,096	871,562

[a] Also yielded 24 tons of concentrate.
[b] Also yielded 124 tons of concentrate.
[c] Includes bullion from 17,736 tons of old tailings.
[d] Includes bullion from 2,994 tons of old tailings.
[e] Also yielded 126 tons of concentrate.
[f] Also yielded 117 tons of concentrate.
[g] Also yielded 1,211 tons of concentrate.

Concentrating mills in Montana treated nearly 71 per cent of the ore mined. The resulting concentrates had an average value of $34.79 a ton. The quantity of concentrates produced was 45 per cent greater than in the preceding year. The increase was especially marked in copper concentrate and lead-zinc concentrate.

Mine production of metals from Montana concentrates in 1923

By counties

County	Ore to concentrating mills	Concentrates	Gold	Silver	Copper	Lead	Recoverable zinc	Total value of concentrates
	Short tons	*Short tons*	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
Beaverhead	6,210	1,211	132.91	22,531	42,458	226,866		$43,345
Broadwater	5,429	1,379	762.20	301	6,087	8,820	14,944	18,531
Cascade	106,141	5,152	254.07	326,274	580,844	1,345,716	5,075	452,726
Deer Lodge	23,523	503	687.08	231,587				204,104
Granite	99	59	97.12	828		13,020	17,595	4,795
Jefferson	1,729	724	183.20	23,258	6,722	189,808	328,712	59,485
Judith Basin	15,950	3,190	174.70	61,371	1,870	1,200,612		138,253
Lewis and Clark	3,320	664	8.10	14,323	9,051	618,406		56,531
Lincoln	44,982	2,701	468.96	59,845	6,942	2,264,016	69,560	222,998
Madison	200	135	214.04	419		2,197		4,923
Park		117	236.70	68				4,949
Phillips		1,211	3,266.15	341				67,797
Silver Bow	3,848,415	1,488,436	24,503.90	10,931,573	205,838,630	25,488,566	141,012,613	51,101,768
	4,055,998	1,505,482	30,989.13	11,672,719	206,492,604	31,358,027	141,448,499	52,380,205

By kinds of concentrates

Dry and siliceous	6,529	5,356.67	304,068	26,373	7,090		$364,441
Copper	1,301,817	18,630.60	7,182,407	203,004,810			36,116,410
Lead	14,599	1,296.14	328,400	179,564	7,619,874		855,868
Zinc	119,457	2,634.10	1,971,018	1,389,740	8,214,546	106,431,720	9,687,354
Copper-lead	5,121	251.10	325,937	580,601	1,328,566		450,807
Lead-zinc	57,959	2,820.52	1,560,889	1,311,516	14,187,951	35,016,779	4,905,325

Mine production of metals from Montana concentrates in 1923—Continued

Average content

Kind of concentrates	Concentrates	Gold	Silver	Copper	Lead	Recoverable zinc	Total value
	Short tons	*Fine ounces per ton*	*Fine ounces per ton*	*Per cent*	*Per cent*	*Per cent*	
Dry and siliceous	6,529	0.82	46.57	0.20	0.05	----------	$55.82
Copper	1,301,817	.01	5.52	7.80	----------	----------	27.74
Lead	14,599	.09	22.49	.61	26.09	----------	58.63
Zinc	119,457	.02	16.50	.58	3.44	44.55	81.09
Copper-lead	5,121	.05	63.65	5.67	12.97	----------	86.84
Lead-zinc	57,959	.05	26.93	1.13	12.24	30.21	84.63
	1,505,482	.02	7.75	6.86	1.04	4.70	34.79

Crude ore directly smelted in 1923 had an average value of $18.01 a ton, and a large increase was recorded in the quantity of copper ore smelted.

Mine production of metals from Montana crude ore shipped to smelters in 1923

By counties

	Ore	Gold	Silver	Copper	Lead	Recoverable zinc	Total value
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
Beaverhead	444	209.39	19,262	18,338	154,780	----------	$33,654
Broadwater	337	90.02	7,697	8,438	178,753	----------	21,926
Cascade	4,687	285.63	228,465	2,074	474,308	----------	226,752
Deer Lodge	14,038	2,014.49	940	606	6,859	----------	42,983
Fergus	21	1.70	1,100	----------	----------	----------	937
Granite	7,452	793.89	284,343	176,499	145,657	----------	285,713
Jefferson	1,971	522.97	31,330	19,267	221,074	----------	54,809
Judith Basin	1,023	49.20	26,776	2,560	490,999	----------	57,719
Lewis and Clark	1,225	2,362.90	18,834	47,004	125,134	----------	79,959
Madison	1,144	1,130.37	16,224	13,258	208,752	----------	53,233
Meagher	117	53.62	72	12,776	9,217	----------	3,690
Mineral	44	1.90	955	2,300	11,595	----------	1,972
Missoula	68	1.10	538	928	16,392	11,893	2,556
Park	117	1.50	3,943	182	31,529	----------	5,498
Powell	572	663.62	11,631	802	85,680	----------	29,372
Sanders	72	1.92	1,754	17,622	15,045	----------	5,122
Silver Bow	146,057	5,426.56	853,205	10,287,013	13,174	----------	2,324,918
	179,389	13,610.78	1,507,069	10,609,667	2,188,948	11,893	3,230,813

By kinds of ore

Dry and siliceous	38,015	11,203.43	875,501	23,898	35,337	----------	$955,493
Copper	133,216	851.28	384,774	10,549,262	1,864	----------	1,883,984
Lead	7,875	1,536.15	232,079	18,956	2,031,226	----------	367,033
Copper-lead	249	19.92	14,622	17,551	116,493	----------	23,136
Lead-zinc	34	----------	93	----------	4,028	11,893	1,167

Average content

	Short tons	*Fine ounces per ton*	*Fine ounces per ton*	*Per cent*	*Per cent*	*Per cent*	
Dry and siliceous	38,015	0.29	23.03	0.03	0.05	----------	$25.13
Copper:							
Oxidized	967	.01	3.08	11.03	----------	----------	35.11
Sulphide	132,249	.01	2.87	3.90	.01	----------	13.99
Lead:							
Oxidized	790	.10	16.32	.10	13.69	----------	34.87
Sulphide	7,085	.21	30.94	.12	12.80	----------	47.91
Copper-lead:							
Oxidized	210	.05	65.91	3.60	25.00	----------	100.67
Sulphide	39	.24	20.00	3.09	14.70	----------	51.15
Lead-zinc: Sulphide	34	----------	2.74	----------	5.92	17.49	34.32
	179,389	.08	8.40	2.96	.61	----------	18.01

PRODUCTION BY COUNTIES

GENERAL FEATURES

In the following pages production is reported by counties, and a statement of the production of each important mining district is given. No mention is made of many districts in which production was small.

Mine production of gold, silver, copper, lead, and zinc in Montana in 1923

County	Gold					Silver	
	Placers		Deep mines		Total value	Fine ounces	Value
	Fine ounces	Value	Fine ounces	Value			
Beaverhead	20.65	$427	345.69	$7,146	$7,573	70,877	$58,119
Broadwater	32.27	667	936.15	19,352	20,019	18,880	15,482
Cascade			539.72	11,157	11,157	555,357	455,393
Deer Lodge	6.29	130	2,701.55	55,846	55,976	232,527	190,672
Fergus	7.50	155	125.77	2,600	2,755	1,232	1,010
Granite	397.98	8,227	1,008.14	20,840	29,067	286,782	235,161
Jefferson	10.30	213	6,954.05	143,753	143,966	107,921	88,495
Judith Basin			223.93	4,629	4,629	88,147	72,281
Lewis and Clark	126.98	2,625	15,401.54	318,378	321,003	49,791	40,829
Lincoln			468.95	9,694	9,694	59,845	49,073
Madison	713.77	14,755	2,585.60	53,449	68,204	18,352	15,049
Meagher	28.98	599	53.64	1,109	1,708	76	62
Mineral	228.33	4,720	16.45	340	5,060	967	793
Missoula	29.41	608	255.66	5,285	5,893	609	499
Park	2.37	49	8,049.60	166,400	166,449	4,938	4,049
Phillips			12,538.85	259,201	259,201	33,661	27,602
Powell	176.81	3,655	669.80	13,846	17,501	11,662	9,562
Ravalli	40.88	845	4.50	93	938	7	6
Sanders	1.89	39	1.88	39	78	1,754	1,438
Silver Bow	134.14	2,773	30,225.28	624,812	627,585	11,837,475	9,706,730
Toole	14.13	292			292	2	2
	1,972.68	40,779	83,106.75	1,717,969	1,758,748	13,380,862	10,972,307

County	Copper		Lead		Recoverable zinc		Total value
	Pounds	Value	Pounds	Value	Pounds	Value	
Beaverhead	151,607	$22,286	2,211,796	$154,826			$242,804
Broadwater	15,349	2,256	642,101	44,947	14,944	$1,016	83,720
Cascade	582,918	85,689	1,824,454	127,712	5,075	345	680,296
Deer Lodge	606	89	6,859	480			247,217
Fergus							3,765
Granite	176,499	25,945	158,677	11,107	17,595	1,197	302,477
Jefferson	39,919	5,868	520,422	36,430	328,712	22,352	297,111
Judith Basin	4,430	651	1,691,611	118,413			195,974
Lewis and Clark	56,055	8,240	743,540	52,048			422,120
Lincoln	6,942	1,021	2,264,016	158,481	69,560	4,730	222,999
Madison	13,258	1,949	210,949	14,766			99,968
Meagher	12,776	1,878	9,217	645			4,293
Mineral	2,300	338	11,595	812			7,003
Missoula	928	136	16,392	1,147	11,893	809	8,484
Park	182	27	31,529	2,207			172,732
Phillips							286,803
Powell	802	118	85,680	5,998			33,179
Ravalli							944
Sanders	17,622	2,591	15,045	1,053			5,160
Silver Bow	223,043,071	32,787,332	25,501,740	1,785,122	141,012,613	9,588,858	54,495,627
Toole							294
	224,125,264	32,946,414	35,945,623	2,516,194	141,460,392	9,619,307	57,812,970

Ore sold or treated, mines producing, and average value per ton of ore in Montana in 1922 and 1923

County	Ore sold or treated, 1923 (short tons)		Number of deep mines producing		Average value per ton [a]		Average value per ton in gold and silver [a]	
	Quantity	Increase or decrease	1922	1923	1922	1923	1922	1923
Beaverhead	26,220	+3,847	10	13	$9.83	$9.24	$6.94	$2.49
Broadwater	11,486	+2,695	12	20	4.83	7.23	4.47	3.03
Cascade	110,939	+91,226	17	17	34.49	6.13	30.16	4.21
Deer Lodge	37,561	−112	6	8	6.75	6.58	6.69	6.56
Fergus	121	−4,954	9	3	6.46	29.83	6.46	29.83
Granite	7,770	−16,495	30	36	33.52	37.86	29.51	32.93
Jefferson	46,267	−17,949	51	28	5.64	6.42	4.98	5.02
Judith Basin	16,973	+1,866	8	5	13.56	11.55	6.47	4.53
Lewis and Clark	33,195	+5,020	38	32	10.23	12.64	10.01	10.82
Lincoln	44,982	−18,697	3	2	4.80	4.96	1.74	1.31
Madison	5,658	−15,885	49	48	11.49	15.04	10.35	12.09
Meagher	117	+53	4	4	42.53	31.55	31.27	9.98
Mineral	64	−139	1	3	66.58	35.58	39.61	17.61
Missoula	468	+342	3	3	28.66	16.82	20.36	12.35
Park	44,546	+7,625	3	2	4.51	3.88	4.45	3.83
Phillips	95,165	+68,765	1	2	2.96	3.01	2.96	3.01
Powell	583	−153	13	14	56.09	50.60	47.28	40.11
Ravalli	4	+2	1	1	38.00	23.75	35.50	23.75
Sanders	72	+18	4	5	60.90	71.12	29.11	20.51
Silver Bow	5,261,344	+1,250,585	51	58	10.25	10.36	2.73	1.96
Sweet Grass		−3	1		124.67		71.00	
	5,743,535	+1,357,657	315	301	10.23	10.06	3.20	2.21

[a] Value per ton, placer product excluded.

Number and production of producing placer mines in Montana in 1922 and 1923

County	1922						1923					
	Mines			Gold	Silver (fine ounces)	Total value	Mines			Gold	Silver (fine ounces)	Total value
	Hydraulic, dry, and sluicing	Dredging	Drift				Hydraulic, dry, and sluicing	Dredging	Drift			
Beaverhead	6			$1,572	5	$1,577	4			$427	1	$428
Broadwater	4		1	1,072	7	1,079	5			667	6	672
Cascade	1			18		18						
Deer Lodge	3			533		533	1			130		130
Fergus	1			39		39	1			155	1	156
Gallatin	1			27		27						
Granite	3			7,746	114	7,860	9			8,227	117	8,323
Jefferson	5			251	3	254	3			213	5	217
Lewis and Clark	9		3	3,984	28	4,012	11		2	2,625	23	2,644
Madison	4	1	1	38,577	393	38,970	10			14,755	144	14,873
Meagher	2			598	6	604	1			599	4	602
Mineral	10			5,410	9	5,419	10			4,720	8	4,726
Missoula	4			679	1	680	3			608	2	610
Park	2		1	367	3	370	1			49		49
Powell	8		1	7,816	57	7,873	7			3,655	28	3,678
Ravalli	2			641	2	643	3			845	5	849
Sanders							1			39		39
Silver Bow	5			2,456	24	2,480	4			2,773	14	2,784
Toole							2			292	2	294
	70	1	7	71,786	652	72,438	76		2	40,779	360	41,074

BEAVERHEAD COUNTY

Argenta district.—Five deep mines in the Argenta district produced 123 tons of ore, containing $738 in gold, 1,575 ounces of silver, 221 pounds of copper, and 49,750 pounds of lead, valued in all at $5,544, or $45.07 a ton. Most of the output was oxidized lead ore from the Midnight, Tilden, and Tuscarora properties.

Bald Mountain district.—A little placer gold was produced from the Double Eagle placer, near Bannack.

Bannack district.—Two lots of rich gold ore were shipped from the Gold Bug property.

Beaverhead district.—Unusually fine placer gold was produced from the I. X. L. property, on Cow Creek.

Blacktail district.—The Blue Bird prospect was operated by the South African Development Corporation, and one lot of sulphide copper ore was shipped to the smelter at Anaconda.

Blue Wing district.—One lot of high-grade silver ore was shipped from the New Departure property, near Dillon.

Bryant district (Melrose).—The output of the Bryant district consisted of oxidized copper-lead ore from the Hecla property and more than 19,000 tons of old slag from the Glendale dump made from ores originally mined from the Hecla group. The ore and slag had a total value of $186,574, or $9.43 a ton. In the last decade the production of the Bryant district has been small, but from 1873 to 1912 it amounted to 370,365 tons of ore, valued at $15,524,475,[2] principally for silver and lead. From 1878 to 1891 the yearly output, chiefly from the Hecla property, was valued at more than $500,000.

Elkhorn district (Wise River).—The old Montana group was operated a short time by the Boston-Montana Corporation, and some lead concentrate was shipped to smelting plants as a result of the operations of the 750-ton mill equipped for concentration and flotation. The company suffered from financial difficulties, and the property was in the hands of a receiver.

Jake Creek district (unorganized).—One lot of silver ore was shipped from the Jake Creek property, 21 miles southeast of Dillon.

Utopia district.—One test lot of copper ore was shipped from the Indian Queen mine, near Apex.

Monida district (unorganized).—A little placer dust was recovered from the Paul property, near Monida.

BROADWATER COUNTY

Backer district (Canton).—Three placers and two deep mines in the Backer district produced gold and silver valued at $2,372. The ore was valued at $143.31 a ton. The Slim Jim property, near Canton, produced rich free-milling gold ore. The Triple group, at the head of Johnny's Gulch, also produced rich gold ore. Small lots of placer gold were taken out of Confederate Gulch, near Townsend.

Beaver district.—Lead ore containing considerable silver was shipped from the Little Olga and Quartette properties, near Winston.

Cedar Plains district (Radersburg).—One placer and nine deep mines produced 11,267 tons of ore and old slag, $16,583 in gold,

[2] Winchell, A. N., Mining districts of the Dillon quadrangle, Montana, and adjacent areas: U. S. Geol. Survey Bull. 574, p. 86, 1914.

12,383 ounces of silver, 6,911 pounds of copper, and 547,618 pounds of lead, valued in all at $66,086. The ore had an average value of $5.85 a ton. Most of the gold came from the Keating property, where sulphide iron ore was concentrated. Much of the silver and lead resulted from the resmelting of old slag shipped from Toston, where smelting operations ceased in 1891. Several cars of sulphide lead ore of good grade were shipped from the Daisy Dandy mine. Other producers were the South Ruby, Kahoka, North Home, and Surprise. A little placer gold was produced from the Charity Gulch placer, near Radersburg.

Hellgate district.—One lot of sulphide copper ore was shipped from the Eclipse-Argo mine, a large producer of copper from 1916 to 1918.

Park district (Townsend).—One placer and five deep mines in the Park district produced 163 tons of ore, $1,033 in gold, 4,045 ounces of silver, 75,292 pounds of lead, and 14,944 pounds of recoverable zinc, valued in all at $10,637. The ore had an average value of $65.03 a ton. The output was made up of small lots from the Black Friday, Silver Wave, Iron Mask, Mammoth, and Pittsburg mines. Silver-lead ore of good grade was shipped from the Mammoth property, on Eagle Creek.

CASCADE COUNTY

Mine production of gold, silver, copper, lead, and zinc in Cascade County, Mont., in 1923

	Number of producers	Ore	Gold	Silver	Copper	Lead	Recoverable zinc	Total value
		Short tons		*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
1923	17	110,939	$11,157	555,357	582,918	1,824,454	5,075	$680,296
Increase or decrease from 1922	−1	+91,226	+3,544	−31,610	+582,862	+273,578	+5,075	+410

The refining of copper bullion, roasting and leaching of zinc ore, and manufacture of slab zinc, cadmium, copper rods, and wire are carried on at Black Eagle, near Great Falls. These plants, which had been operated part time in 1922, were active throughout 1923. Ore receipts consisted of zinc ore and concentrate, chiefly from Butte but partly from Idaho and other States. The output of the electrolytic zinc plant was gradually increased and averaged more than 6,000 tons of slab zinc and zinc in dross a month. The zinc residue shipped to lead plants contained gold, silver, copper, and lead. For a time one blast furnace was used on residue mixed with flue dust to make lead bullion, but this practice was not continued, and most of the residue was shipped to East Helena, Mont., or Tooele, Utah. The operations at Butte, Anaconda, and Great Falls are unusually complete, as the copper and zinc from the Butte mines are put on the western market in finished form. The production is given in the report on the Anaconda Copper Mining Co. under Silver Bow County.

The entire mine output of Cascade County came from the Montana district, at Neihart. The Silver Dyke Mining Co., controlled

by the American Zinc, Lead & Smelting Co., produced a large quantity of copper-lead ore containing silver, which was treated in the new 500-ton concentration-flotation plant completed in March. Several thousand tons of copper-lead concentrate was shipped to smelters at East Helena, Mont., and International, Utah. Much development work was done on the property, which is opened by nearly 6,000 feet of drifts and raises. The success of this work was demonstrated by the willingness of the controlling company to supply the funds for mill building. The company reports reserves of about 1,000,000 tons of mill ore containing copper, lead, and silver. About 2,000 tons of lead ore, rich in silver, was shipped from the Hartley mine, operated by the Neihart Consolidated Silver Mining Co., but the property was closed in June. A quantity of silver ore averaging about 60 ounces to the ton was shipped from the Benton group. Other producers of note were the Big Seven, Florence, Moulton, Galt, Ripple, Queen of the Hills, Rock Creek, Silver Belt, I. X. L., Peabody, and Alexander mines. The Cascade Silver Mines Co., owning the Broadwater and Moulton mines and concentration plant at Neihart, produced a comparatively small quantity of ore by lessees.

DEER LODGE COUNTY

Mine production of gold, silver, copper, and lead in Deer Lodge County, Mont., in 1923

	Number of producers	Ore	Gold [a]	Silver	Copper	Lead	Total value
		Short tons		*Fine ounces*	*Pounds*	*Pounds*	
1923	9	37,561	$55,976	232,527	606	6,859	$247,217
Increase or decrease from 1922		−112	+7,224	+28,570	−2,071	−21,900	−7,435

[a] Includes small placer production.

The output of Deer Lodge County was mainly silver ore and gold-bearing iron ore, which was used as a flux in smelting. At Anaconda, where most of the copper ore and much of the zinc ore and lead-zinc ore mined in Montana were treated, the copper and zinc concentrators, copper-smelting plant, and arsenic plant were active throughout 1923, but the price of copper was not sufficiently high to induce a record-breaking output. Reverberatories and converters were used, but the blast furnaces and the copper-leaching plant were idle. The results of smelting operations are given in the report on the Anaconda Copper Mining Co. under Silver Bow County.

Dry Gulch district.—A little placer gold was mined from glacial gravel from the Dry Gulch placer, 10 miles north of Anaconda.

Georgetown district (*Southern Cross*).—Four deep mines in the Georgetown district produced 14,007 tons of ore, containing $41,484 in gold, or $2.96 a ton. All the output was oxidized iron ore shipped from the Golden Wedge, Hold Fast, Oro Fino, and Short Shift mines and used as a flux at the smelter. The largest output came

from the Short Shift mine, the ore of which averaged about 0.41 ounce of gold to the ton. The Southern Cross mine was idle, but development work was done at the Bob Evans property in opening oxidized iron ore.

Oro Fino district.—The mill of the Champion group, owned by the Butte Jardine Metals Mines Co., was operated at capacity until June, after which the property was worked half time. Several hundred tons of silver concentrate was shipped to the smelter at Anaconda. The property is said to have in reserve a large quantity of ore containing 12 ounces of silver and a little gold to the ton. As it was not profitable to operate when the price of silver was 62 cents an ounce, the mine was closed.

Blue Eyed Nellie district (unorganized).—One shipment of silver-lead ore was made from the George property.

FERGUS COUNTY

Mine production of gold and silver in Fergus County, Mont., in 1923

	Number of producers	Ore	Gold [a]	Silver [a]	Total value
		Short tons		*Fine ounces*	
1923	4	121	$2,755	1,232	$3,765
Decrease from 1922	6	4,954	27,115	1,725	29,062

[a] Includes placer production.

All the ore produced in Fergus County was siliceous, and most of it was treated by cyanidation. The ore milled had an average value of $26.72 a ton. A decided decrease resulted from the closing of the North Moccasin mine at Kendall.

North Moccasin district (Kendall).—A small quantity of placer gold was mined at the Bed Rock property, near Kendall. The Barnes King Development Co. did no mining or milling at the Kendall or North Moccasin properties, as all known ore has been mined. The returns on gold bullion from the North Moccasin mine from 1911 to 1922 amounted to $2,167,313.

Warm Springs district (Giltedge).—Three deep mines in the Warm Springs district produced 121 tons of ore, containing $2,600 in gold and 1,231 ounces of silver, valued together at $3,609, or $29.83 a ton. One lot of silver ore was shipped from the Silver Queen mine, near Hilger, and gold bullion was recovered from cyanide operations at the Maginnis and Cumberland mines. Development work was done under lease at the Maginnis mine, which is equipped with a 30-ton cyanide plant. No mining was done at the Cumberland mine, in Spotted Horse Canyon, but material around the mill was cleaned up. The Mammoth mine of the Judith Mountain Gold Mining Co. was idle, the mill having burned in 1922, but the company reports 25,000 tons of gold ore in reserve. Several thousand tons of gold ore is also in reserve at the Silver Bullion mine.

GRANITE COUNTY

Mine production of gold, silver, copper, lead, and zinc in Granite County, Mont., in 1923

	Number of producers	Ore	Gold [a]	Silver [a]	Copper	Lead	Recoverable zinc	Total value
		Short tons		*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
1923	45	7,770	$29,067	286,782	176,499	158,677	17,595	$302,477
Increase or decrease from 1922	+12	−16,495	−40,564	−367,507	+146,896	−372,808	−1,106,760	−518,759

[a] Includes placer production.

The quantity of ore sold or treated in Granite County in 1923 was 68 per cent less than in 1922, and the value of the metal output, which was mostly silver, decreased more than half a million dollars.

Alps district.—One lot of ore was treated by amalgamation in a 5-stamp mill at the Rainy Day property.

Dunkleberg district.—The Forest Rose mine was operated by the Butte & Western Mining Co., which shipped several hundred tons of oxidized lead ore to the smelter at East Helena and several lots of lead-zinc ore to a custom mill at Butte. One test lot of silver ore was shipped from the Pantheon mine, in Jackson Gulch.

First Chance district (Garnet).—Five placers and four deep mines in the First Chance district produced 209 tons of ore, $8,072 in gold, 319 ounces of silver, and 169 pounds of lead, valued in all at $8,345. The ore had an average value of $36.23 a ton. Most of the output was gold ore from the Magone & Anderson, Shamrock, and Gold Center properties. The Fourth of July mine, operated by the Butte Garnet Consolidated Gold Mines Co., produced gold bullion and concentrate from milling operations. The placer output contained gold valued at $769 and 4 ounces of silver, which came principally from the Hilltop, Barney Gulch, and Welcome Gulch placers.

Flint Creek district (Philipsburg).—Nineteen deep mines in the Flint Creek district produced 6,783 tons of ore, containing $11,187 in gold, 274,082 ounces of silver, 173,939 pounds of copper, and 28,223 pounds of lead, valued in all at $263,479, or $38.84 a ton. Nearly all the output was first-class shipping ore valuable for its silver. The largest producers were the Algonquin group, operated by the Philipsburg Mining Co., and the Granite-Bimetallic mine, operated by the Granite-Bimetallic Consolidated Mining Co. Other properties producing several hundred tons of ore each were the Trout, Scratchall, Pocahontas, and Gold Coin mines. The Philipsburg Mining Co. also has in reserve considerable manganese ore, consisting of pyrolusite and psilomelane. The Gold Coin Mining Co. operated the Huffman or Copper State property, near Maxville, and shipped several hundred tons of oxidized copper ore of good grade. The Granite-Bimetallic property was not operated vigorously after the decrease in the price of silver, but the company reports a large quantity of silver ore on hand, which is said to

average 15 ounces to the ton. Other shipments were made from the Moorelight, Hobo, Juniper, Eleanor, Londonderry, Young America, Sanders, Last Chance, and Old Chief properties.

Moose Lake district.—One lot of rich silver ore was shipped from the Banner mine, near Philipsburg.

Red Lion district.—The Badger Montana Mining Co. is developing a 60-foot vein of gold-bearing iron ore 6 miles from Southern Cross.

Rock Creek district.—A little gold ore was tested by cyanidation at the Lee property, and considerable placer gold was mined by the Basin Mining Co.

South Boulder district (Maxville).—Eight deep mines in the South Boulder district produced 109 tons of ore, containing $289 in gold, 4,326 ounces of silver, 1,972 pounds of copper, and 14,677 pounds of lead, valued in all at $5,153, or $47.27 a ton. Most of the output was mined at the Moonlight, Sunnyside, and Comet properties.

JEFFERSON COUNTY

Mine production of gold, silver, copper, lead, and zinc in Jefferson County, Mont., in 1923

	Number of producers	Ore	Gold [a]	Silver [a]	Copper	Lead	Recoverable zinc	Total value
		Short tons		*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
1923	31	46,267	$143,966	107,921	39,919	520,422	328,712	$297,111
Increase or decrease from 1922	−25	−17,949	−598	−67,566	−37,205	−57,281	+324,915	−65,343

[a] Includes placer production.

The value of the output of Jefferson County decreased on account of the closing of the tailings mill at Elkhorn in May. The zinc output, however, was increased by the milling of lead-zinc ore from the Colorado district.

Amazon district.—Three deep mines in the Amazon district produced 583 tons of ore and old slag, containing $2,189 in gold, 9,995 ounces of silver, 554 pounds of copper, and 3,967 pounds of lead, valued in all at $10,744, or $18.43 a ton. Several hundred tons of ore was shipped from the Bismark property, and one lot of silver ore from the Great Northern claim.

Boulder district.—From the Adolphus mine, one of the oldest producers of Montana, one lot of gold and silver ore was shipped.

Cataract district (Basin).—Two placers and nine deep mines in the Cataract district produced 412 tons of ore, $2,412 in gold, 8,131 ounces of silver, 9,142 pounds of copper, and 24,833 pounds of lead, valued in all at $12,161. The ore had an average value of $29.06 a ton. The output of the district was unusually small, as no lead-zinc ore was shipped from the Crystal and Grey Eagle mines. The Jib Consolidated Mining Co. shipped only two lots of ore, but considerable work was done in the construction of a 300-ton mill equipped for concentration and flotation. In the mine more than 2,000 feet of development work was done, and the property was

opened for ore production after the faulted extension of the main ore body was discovered. The property will be a large producer in 1924.

The Morning Glory, Crystal, and King Cole properties produced several lots of silver ore, and the Buckeye, West Rumley, and Red Wing mines sulphide lead ore. Small lots of placer gold were mined on Bernice Creek. The Lowland Ruby Mining Co. owns a 10-stamp mill near Basin and reports a large quantity of gold-silver ore in reserve.

Colorado district (*Wickes*).—Five deep mines in the Colorado district produced 3,903 tons of ore and slag, containing $8,713 in gold, 32,424 ounces of silver, 26,151 pounds of copper, 478,237 pounds of lead, and 314,912 pounds of recoverable zinc, valued in all at $94,036, or $24.09 a ton. The output was made up of 1,677 tons of milling ore, 736 tons of first-class ore, and 1,490 tons of old slag. The Mount Washington mine was operated by the Angelica Mining & Development Co., which shipped crude lead ore to East Helena and lead-zinc ore to the custom milling plant at Butte. The concentration mill owned by the company was destroyed by fire and has not been replaced. Considerable slag, containing chiefly silver and lead, was shipped from the old smelter dump near Wickes.

Elkhorn district.—Five deep mines in the Elkhorn district produced 41,281 tons of ore and old tailings, containing $129,491 in gold, 56,889 ounces of silver, 4,038 pounds of copper, and 7,090 pounds of lead, valued in all at $177,230, or $4.29 a ton. Nearly all the ore and old tailings was milled either by cyanidation or by concentration and cyanidation. The Swissmont property was operated by the East Butte Mining Co., and a large quantity of low-grade gold ore treated in the cyanidation plant, which has a capacity of 175 tons a day. The gold is associated with hematite, magnetite, limonite, and pyrite. Though the property was one of the large producers of gold in 1923, it was closed in December, as the ore found at depth could not be profitably treated. The company's printed annual report for 1923 gives the following information:

> Development work on the 200 level of the gold property owned by the Pittsmont Copper Co. at Elkhorn, Mont., was a keen disappointment. Only 14,000 tons of commercial ore were obtained from this work; and as all ores carrying commercial values had previously been mined out above the 100 level, mining operations were discontinued on this property in September. Milling operations were carried on with material recovered from old dumps on the property and low-grade ores obtained from development work on the Hoffman property until early in December. The Hoffman group of claims adjoin the Pittsmont property to the west, and the development of this property was undertaken under an option to purchase, agreement entered into on the 23d day of August, 1923. As soon as it was definitely ascertained that the showing on this property did not warrant further expenditures all development work was stopped and milling operations were discontinued
>
> The total operating loss, which amounted to $24,358.89 for a period of 27 months, is traceable to unfavorable developments on the 200 level, to the high cost of wages and materials, and to lower recoveries than those obtained in preliminary tests, due to changes in the character of the ore.

The Western Metallurgical Co. operated its mill about five months and shipped cyanide precipitates containing silver to Bradley, Idaho, and a rich silver flotation concentrate to East Helena. The decrease in the price of silver, however, forced the company to suspend operations.

Homestake district.—One small lot of gold ore was shipped from the Hackensack prospect, 6 miles from Homestake.

Lump Gulch district (Clancey).—The Willard mine produced one car of lead-zinc ore, which was shipped to Butte for concentration. Considerable gold ore of milling grade is said to be in reserve at the Searchlight property.

Woodland Park district.—One lot of gold ore was shipped from the Center Reef or Ballard group, near Jefferson City, and a test lot of oxidized lead ore from the Deer Horn prospect.

JUDITH BASIN COUNTY

Barker district (Hughesville).—Five deep mines in the Barker district produced 16,973 tons of ore, containing $4,629 in gold, 88,147 ounces of silver, 4,430 pounds of copper, and 1,691,611 pounds of lead, valued in all at $195,974, or $11.55 a ton. The ore was divided into 1,023 tons of first-class lead ore and 15,950 tons of milling ore, which was reduced to 3,190 tons of lead concentrate. Small lots of sulphide lead ore were shipped from the August, Last Chance, Liberty, and Dannie T. properties. The greater part of the production was that of the Wright & Edwards mine, owned by the Block P. Mining Co. The mine was operated continuously, and development consisted of 1,400 feet of drifting. The mill was idle only a few weeks, and several thousand tons of rich silver-lead concentrate with some first-class ore was shipped to the smelter at East Helena. The company reports more than 100,000 tons of silver-lead ore in reserve for future milling operations.

LEWIS AND CLARK COUNTY

Mine production of gold, silver, copper, and lead in Lewis and Clark County, Mont., in 1923

	Number of producers	Ore	Gold	Silver	Copper	Lead	Total value
		Short tons		*Fine ounces*	*Pounds*	*Pounds*	
Placers	13		$2,625	23			$2,644
Deep mines	32	33,195	318,378	49,768	56,055	743,540	419,476
		33,195	321,003	49,791	56,055	743,540	422,120
Increase from 1922		5,020	65,724	19,166	46,625	653,517	129,992

The ore mined in Lewis and Clark County in 1923 was 18 per cent more than in 1922, and most of it was treated in milling plants by cyanidation. In December the Shannon mine, the second largest producer of gold in Montana, was closed. Smelting operations at East Helena were continued at a greatly increased rate of output. Three blast furnaces, moved from the plant at Northport, Wash., were in operation early in the year to take care of additional ore and concentrate from Idaho. Custom material was received from Montana, Idaho, and Washington, but the bulk of the lead ore was mined in Idaho.

Bald Butte district (*Marysville*).—A few tons of rich gold ore was shipped from the Bald Butte property, and several lots of lead ore from the Carbonate mine.

Dry Gulch district.—Five placers and two deep mines in the Dry Gulch district produced 60 tons of ore, $2,819 in gold, 318 ounces of silver, and 77 pounds of lead, valued in all at $3,085. Two cars of rich gold ore were shipped from the Producer mine, and most of the placer gold came from the Blue Jay and Jim Town claims, in Kingsbury Gulch near York.

Grass Valley district.—Silver ore was shipped from the Gray Eagle, Carbonate Hill, and Nora Darling mines, and one lot of lead ore from the Lone Pine property.

Greenhorn district.—A little gold ore from the Umatilla property was treated in an amalgamation mill.

Heddleston district.—The Mike Horse mine was operated by the Sterling Mining & Milling Co., and several hundred tons of lead concentrate was shipped as a result of the operation of the 100-ton concentration plant. A wide vein of ore containing lead and zinc is opened by an adit 1,200 feet long. The milling plant was remodeled, and flotation machines were added.

Helena district.—Several lots of placer gold were mined in Last Chance Gulch in the vicinity of Helena.

Lincoln district.—Three placers in the Lincoln district produced $296 in gold and 1 ounce of silver. The Harvey placer, 10 miles from Lincoln, was operated by sluicing.

Ottawa district (*Marysville*).—Six deep mines and two placers in the Ottawa district produced 13,940 tons of ore and old tailings, $286,772 in gold, 18,911 ounces of silver, 579 pounds of copper, and 14,298 pounds of lead, valued in all at $303,365. The ore had an average value of $21.76 a ton. The output consisted of 12,141 tons of ore and 1,200 tons of old tailings treated by cyanidation and 599 tons of first-class ore. Several hundred tons of rich gold ore was shipped from the Drumlummon property, a large producer in the past, chiefly from 1901 to 1907. The mine is opened by 25 miles of underground workings and has a 75-ton mill equipped for cyanidation and a large dump of old tailings. Under new management the property will be actively operated in 1924. Ore and tailings were treated by cyanidation at the Penobscot and Drumlummon dumps by lessees. One lot of lead ore was shipped by the Towsley Mining Co. The largest production of the district was that of the Shannon mine, operated by the Barnes King Development Co. Gold ore of good grade was treated in the 150-ton cyanidation mill. The company's annual report for 1923 says:

> Ore treated by fine grinding and cyanidation totaled 11,986 tons dry, of a gross bullion value of $245,252.41, or $20.46 per ton.
>
> Milling costs per ton of ore treated were higher than usual, due to the small tonnage treated, and are not comparable with costs of previous years or costs in similar fine-grinding mills. * * *
>
> Production of ore for the year stopped early in December. The greater part of the tonnage came from the pillars about the working shaft and under the tunnel-level track.
>
> At the end of 1922 the ore reserves of the Shannon were estimated at 9,050 tons, and the most likely place for favorable development appeared to be the 700 level. Such work was carried on during the early months of 1923 and amounted to 340 feet, making a total for the level of 1,183 feet in drifts and

raises on the vein. This work, however, proved so disappointing that, taken in connection with the low-grade, spotted, and base character of the ore stoped, in April it was decided to abandon the bottom of the mine as worked out. It should be recalled that the 700 level was opened by a winze sunk in the most promising place on the 600 level, at a point approximately 800 feet west of the working shaft. All development work, therefore, was stopped in April, 658 feet having been done during the first three months of the year, and tracks, pipe lines, tools, and pumps on the 700, 600, and 500 levels were hoisted from the mine and stoping of shaft pillars commenced. This was continued successfully until all ore was removed, as well as the remaining equipment, and the mine finally closed December 5, with a watchman left in charge.

Scratch Gravel district.—Several lots of lead ore containing gold and silver were shipped from the Franklin and Bonanza properties. In October operations were started at the Scratch Gravel mine, which was a large producer of gold ore from 1915 to 1918.

Sevenmile district.—Development work was done at the Silver King property, and lead ore was shipped to the smelter at East Helena.

Stemple district.—Old tailings from the Bachelor mine, at Stemple, were treated by cyanidation, and gold and silver bullion was shipped to an eastern refinery. A test lot of ore from the Klondyke property was treated by amalgamation.

Unionville district.—Material from the Whitlatch mine 5 miles south of Helena, a large producer in the past, was treated by sluicing. The mine is equipped with a 40-ton mill and retimbering was done to prepare for deep mining.

Wolf Creek district—Several cars of oxidized copper ore were shipped from the New Era group near Wolf Creek.

Vaughn district (Rimini).—One placer and five deep mines in the Vaughn district produced 13,717 tons of ore, $21,285 in gold, 4,804 ounces of silver, 726 pounds of copper, and 59,830 pounds of lead, valued in all at $29,520. The ore had a value of $2.15 a ton. Most of the output was low-grade gold ore from the Porphyry Dike property. The 300-ton mill equipped for amalgamation was remodeled and operated from July to December, and considerable gold bullion was shipped to the assay office at Helena. Several lots of sulphide lead ore were shipped to the smelter from the Little Lily mine, and test lots were shipped from the Anna May and Loeber properties. The Lee Mountain mine, which was idle, is said to have in reserve 100,000 tons of ore, which contains gold, silver, lead, and arsenic.

LINCOLN COUNTY

Libby district.—The Lukens Hazel mine was operated from June to December by the Libby Mines & Holding Co. Several hundred tons of lead concentrate containing gold and silver resulted from the operation of the 150-ton plant equipped for concentration and flotation. The property is opened by an inclined shaft 450 feet deep, and 200 feet of drifting was done in 1923. Silver-lead ore is also being developed at the Mountain Rose, Silver Mountain, and other prospects near Libby.

Troy district (Callahan Creek).—Considerable silver-lead concentrate was shipped from the Snow Storm mine, near Troy. The ore contains galena and sphalerite, and the mine has been a large producer of gold, silver, lead, and zinc since 1917. The company was

reorganized in 1923, and much development work was done on the lowest tunnel level, which is said to have opened much milling ore. A short article[3] published in December summarized the conditions of mining, milling, and financing. The income from concentrates and other sources was $137,558, and the expenses were $185,545. The company's annual report for 1923 gives the following notes:

> We have extracted most of the ore above the No. 7 tunnel level and are cleaning up the remaining stopes and pillars there.
>
> The station for the three-compartment shaft has been completed, hoist installed, and actual sinking is in progress. We expect to cut the first level at 250 feet by May 1 next and, continuing the shaft for two successive levels, be producing ore to capacity of our plant by the end of this year.

Development work done by the Liberty Metals Co. is said to have opened considerable copper ore.

MADISON COUNTY

Mine production of gold, silver, copper, and lead in Madison County, Mont., in 1923

	Number of producers	Ore	Gold	Silver	Copper	Lead	Total value
		Short tons		*Fine ounces*	*Pounds*	*Pounds*	
Placers	10		$14,755	144			$14,873
Deep mines	48	5,658	53,449	18,208	13,258	210,949	85,095
	58	5,658	68,204	18,352	13,258	210,949	99,968
Increase or decrease from 1922	+3	−15,885	−148,675	−26,649	−17,591	−161,709	−186,573

A decided decrease in the output of gold in Madison County was due chiefly to the idleness of placers formerly worked by dredges.

Alder Gulch district (*Virginia City*).—Six placers and five deep mines in the Alder Gulch district produced 650 tons of ore, $18,468 in gold, 8,377 ounces of silver, and 94 pounds of copper, valued in all at $25,351. The ore had an average value of $17.75 a ton. The metal output of the district decreased from $106,385 in 1922 on account of the removal of the dredges owned by the Conrey Placer Mining Co. During November and December ore from the High Up mine was treated in a 25-ton cyanidation plant, and ore containing gold and silver was shipped from the Alameda, Cornucopia, and U. S. Grant mines. Several lots of rich silver ore were shipped from the Native Silver property. Much gold ore of milling grade is blocked out at the Metallic property.

Bone Basin district.—Several hundred tons of lead ore containing considerable gold was shipped from the Florence property, near Renova, and one car of copper ore was shipped to the Pittsmont smelter, at Butte. The Colorado property, 2 miles north of Renova, produced one car of rich gold ore.

Lower Hot Springs district (*Norris*).—Seven deep mines in the Lower Hot Springs district produced small lots of ore valued at $1,389, or $46.30 a ton. One lot of gold ore was shipped from the

[3] Snow Storm Silver-Lead Co.: Min. Truth, Dec. 4, 1923.

Josephine mine and one lot of silver ore from the Morning Star property.

McCarthy Mountains district.—One car of rich gold ore was shipped from the Hidden Treasure property, and several lots of silver-lead ore from the Polly Jane mine.

Mineral Hill district.—The Boss Tweed mine produced considerable gold ore, which was treated by amalgamation and concentration. Bullion and concentrates valued at more than $5,000 were shipped to Helena and Anaconda.

Norwegian district.—Small test lots of gold ore were shipped from the Montana, Gold Hill, and Nabob claims.

Ramshorn district (Laurin).—Two placers and two deep mines in the Ramshorn district produced gold and silver valued at $1,393. The ore had an average value of $42.80 a ton and consisted of small lots shipped from the Harriette and Betsy Baker claims. Placer gold was mined in Harris and Bevine gulches, near Sheridan.

Sheridan district.—Eight deep mines in the Sheridan district produced 1,140 tons of ore, containing $11,369 in gold, 2,977 ounces of silver, and 7,876 pounds of lead, valued in all at $14,361, or $12.60 a ton. The Tamarack mine was operated on a small scale throughout the year, and several hundred tons of gold ore was treated by amalgamation. The Gladstone Mine & Reduction Co. operated the Lakeshore and Gladstone property and did 1,000 feet of development work. The company owns a 100-ton cyanide plant but made no production other than one lot resulting from the testing of 200 tons of ore by concentration. Small lots of ore were shipped from the Fairview, Red Pine, Silver Bar, and Silver Bullion properties.

Silver Star district.—Four deep mines in the Silver Star district produced 58 tons of ore, containing $3,421 in gold and 194 ounces of silver, valued together at $3,580, or $61.72 a ton. Rich gold ore was shipped from the Aurora and Strawn properties, near Silver Star. Sampling and prospecting work was continued at the Strawn mine, which is opened by 1,100 feet of tunnels and drifts.

Summit district (Virginia City).—The output of the Summit district consisted of gold ore from the Mountain Flower and Winnetka mines, most of which was treated by amalgamation and concentration. The Mountain Flower property was operated by the E. M. Smith Mining Co., and several hundred tons of low-grade gold ore was treated in a modern 30-ton milling plant.

Tidal Wave district (Twin Bridges).—Ten deep mines and one placer in the Tidal Wave district produced 261 tons of ore, $6,094 in gold, 2,314 ounces of silver, 986 pounds of copper, and 92,612 pounds of lead, valued in all at $14,620. The ore had an average value of $55.94 a ton. The output consisted of miscellaneous first-class ore from the Empire State, Ella, Dutchland, Sunflower, Texas, Pete & Joe, Lost Cabin, and Isabelle claims. The most valuable product was gold ore from the Pete & Joe mine.

Washington district.—The output of the Washington district consisted principally of gold ore from the Missouri & McKee property, operated by the Montana Gold & Silver Mining & Milling Co. About 1,000 tons of ore was treated by amalgamation and cyanidation in a 50-ton mill.

MEAGHER COUNTY

Beaver Creek district.—Placer gold was mined from the Klondyke claim, on Beaver Creek near Watson.

Little Belt district.—One lot of rich gold ore was shipped to the smelter at Anaconda from the Jack Pine property.

Murray district.—One lot of copper ore was shipped from the Copper Queen claim, near White Sulphur Springs.

Musselshell district.—The Copperopolis mine, an old producer near Delpine, supplied one lot of sulphide copper ore.

MINERAL COUNTY

Cedar Creek district (*Iron Mountain, Quartz*).—Ten placers and one deep mine in the Cedar Creek district produced 20 tons of ore, $5,021 in gold, and 12 ounces of silver, valued together at $5,030. One lot of gold ore treated by amalgamation was mined by the American Gold Mining Co., which owns a prospect near Superior. The placer output, valued at $4,726, was mined principally from the Louisiana, Meadow Creek, Mildred, Stockholm, C. B. & Q., and Marguerite properties.

Iron Mountain district.—The Iron Mountain Tunnel Co., north of Iron Mountain, produced one lot of sulphide lead ore.

St. Regis district.—One lot of sulphide copper ore was shipped from the St. Lawrence property, near Saltese, and 2,000 feet of development work was done at the Amazon Dixie mine.

MISSOULA COUNTY

Coloma district.—Gold ore from the Dandy mine, owned by the Gold Bond Mining Co., was treated by amalgamation and concentration, and the gold was saved chiefly in concentrates shipped to East Helena. Placer gold was mined on Elk Creek near Garnet.

Ninemile district.—A little placer gold was saved at the Boyd and Betty Creek placers, near Stark.

Wallace district.—One lot of copper-lead ore was shipped by the Maine & Montana Copper Co., operating near Clinton.

Nimrod district (*unorganized*).—The Katie mine produced one lot of sulphide-lead ore smelted at East Helena, and another lot of lead-zinc ore was shipped to a zinc plant in the East.

PARK COUNTY

New World district (*Cooke*).—The Irma property, on Republic and Woody mountains, 1½ miles south of Cooke, produced several lots of sulphide-lead ore rich in silver. The Montana Scotch Bonnet mine, owned by the Glengarry Mining Co., was idle, but the company reports a large quantity of first-class and second-class ore in reserve. The Western Smelting & Power Co. constructed a 2-mile tramway from the mine to the smelting plant, which is now nearly complete. The Cooke Consolidated Copper Co. owns property on Henderson Mountain and is said to have ore ready for smelting.

Sheepeater district (*Jardine*).—The Jardine Mining Co. operated its mine and mill throughout the year and treated a large tonnage of gold ore by amalgamation and concentration. Most of the gold was shipped to the assay office at Helena, and after the concentrates

were roasted at the mine, to save the arsenic in arsenopyrite, the calcines were shipped to smelting plants to recover the remaining gold. The milling plant consists of 40 stamps, amalgamation plates, concentration tables, and flotation machines. The arsenic plant erected during the year has a reverberatory furnace, arsenic kitchens, and a bag house. An article describing the property,[4] which ranked fourth as a producer of gold in Montana in 1923, was published in May. The arsenic plant is fully described in another chapter of Mineral Resources.[5] The company's annual report for 1923 gives the following paragraphs:

The mine is capable of supplying a larger tonnage of ore than the mill can handle. For the purpose of increasing the mill capacity as far as possible without much expense, as well as of increasing the percentage of extraction, a 4 by 9 rod mill has been ordered and will soon be installed. By relieving the stamps of the duty of fine crushing, the capacity of the mill will be increased from its present maximum, which is about 140 tons per day, to between 175 and 200 tons per day.

As the supply of ore from the mine was abundant, it was not necessary during the year to prosecute development work intensively, but enough was done to maintain ore reserves, and more ore was available at the end of the year than at its commencement. Large bodies of ore carrying good values in both gold and arsenic have as yet hardly been touched, and some important discoveries of new ore bodies have been made, requiring only ordinary development work to make them available.

Most gratifying of these, perhaps, is the opening of a new ore body on the Iron Duke claim, which is 800 feet easterly and 400 feet higher in elevation than the nearest ore body so far worked. Not only is it apparent that a rich and probably large ore body has been discovered, but its position with reference to the other ore bodies in the company's property is such that its discovery greatly extends the productive area. In order to determine the best plan for developing this ore body, a prospect shaft was sunk to a depth of 40 feet. The ore from it assays $20 in gold per ton and 20 per cent of arsenic, making a gross value of about $50 per ton. As soon as the winter is over a compressed-air line will be extended to this point, and active development work, which will also be productive of good ore, will be commenced. * * *

During the year there were mined and milled 44,429 tons of ore. The cost per ton is $5.11. * * *

The company recovered $154,791 from gold bullion, concentrates, and calcines and $78,657 for arsenic. The net profit was $23,141, not including the value of concentrates on hand.

PHILLIPS COUNTY

Little Rockies district.—Other than a small clean-up made at the Beaver Creek property, the output of the Little Rockies district consisted of gold and silver saved at the Ruby Gulch mine. The 600-ton cyanide plant was operated on low-grade gold ore from January to October, when the mill was destroyed by fire. The property was the second largest producer of gold in Montana in 1923 and a large producer from 1911 to 1918, but it was not operated in 1919 and 1920 on account of the relatively high cost of mining, milling, and supplies.

POWELL COUNTY

Big Blackfoot district.—The Gold Dust placer, on Ogden Mountain, produced gold from stream gravel.

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[4] Eng. and Min. Jour.-Press, May 12, 1923, p. 859.

[5] Heikes, V. C., and Loughlin, G. F., Arsenic in 1923: U. S. Geol. Survey Mineral Resources, 1923, pt. 1, pp. 168–169, 1924.

Mary Ann district.—One shipment of silver-lead ore from the Grey Rock mine was sent to the smelter at East Helena.

Nigger Hill district.—Three deep mines in the Nigger Hill district produced 144 tons of ore, $4,872 in gold, 1,541 ounces of silver, and 16,280 pounds of lead, valued in all at $7,275, or $50.52 a ton. Most of the output was sulphide-lead ore mined at the Black Jack and Big Dick properties.

Ontario district (Elliston).—Small lots of lead ore were shipped from the Monarch and Carbonate King properties, and a little placer dust was washed from the Eddy placer, on Jericho Flat.

Ophir district (Finn).—The Carpenter Bar property, near Avon, produced a small quantity of placer gold.

Snowshoe district.—A small lot of gold ore was treated in an amalgamation mill by the Esmeralda Gold Mining Co. at Elliston.

Pioneer district (Gold Creek).—Three placers in the Pioneer district produced gold valued at $1,804 and 15 ounces of silver. The Friday placer, on Gold Creek, was the largest producer.

Washington Gulch district.—The Fontana placer, near Finn, was active for a short time and produced a little placer gold.

Zozell district.—Three deep mines in the Zozell district produced 309 tons of ore, containing $4,645 in gold, 6,912 ounces of silver, 59 pounds of copper, and 36,085 pounds of lead, valued in all at $12,848, or $41.58 a ton. The ore was shipped from the Bertha May, Blue Eyed Maggie, and Emery Consolidated properties. Most of the output was lead ore containing considerable silver and gold from the Emery mine of the Carbonate Hill Mining Co. The property is equipped with a 75-ton concentration-flotation plant, and a power line for electrical equipment was installed in 1923.

Unorganized district.—One lot of silver ore was shipped from the North Pole mine, southeast of Elliston.

RAVALLI COUNTY

Curlew district.—The Curlew Mining Co., which owns a concentration mill near Victor, did 1,100 feet of development work in shaft and drifts.

Hughes Creek district.—Three placers and one deep mine in the Hughes Creek district produced $938 in gold and 7 ounces of silver. The Hughes Creek placer, near Corvallis, was the largest producer. A little gold ore was treated in an arrastre at the Jim & Star property.

SANDERS COUNTY

Burns district.—The Iron Daisy prospect, 11 miles southwest of Thompson Falls, produced one lot of lead ore.

Camas Prairie district.—The Broken Hill property was under option to the Federal Mining & Smelting Co., and lead-zinc ore was developed by tunnels and drifts.

Thompson River district.—Three deep mines in the Thompson River district produced 53 tons of ore, containing $15 in gold, 1,653 ounces of silver, 17,622 pounds of copper, and 163 pounds of lead,

valued in all at $3,972, or $74.94 a ton. The output consisted of one lot of silver ore from the Silver King property and shipments of sulphide ore from the Copper Mask and Copper King claims.

White Pine Creek district.—One lot of lead ore was shipped from the Idaho Divide property, near White Pine.

SILVER BOW COUNTY

Mine production of gold, silver, copper, lead, and zinc in Silver Bow County, Mont., in 1923

Year	Number of producers	Ore	Gold [a]	Silver [a]	Copper	Lead	Recoverable zinc	Total value
		Short tons		*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
1923	62	5,261,344	$627,585	11,837,475	223,043,071	25,501,740	141,012,613	$54,495,627
Increase from 1922	6	1,250,585	83,839	1,441,595	57,668,668	5,361,771	23,070,947	13,400,083

[a] Includes placer production.

Most of the output of Silver Bow County in 1923 was produced by eight companies. The large producing mines at Butte were active throughout the year, and the metal output was therefore decidedly increased. The largest part of the ore produced was concentrated at milling plants at Butte and Anaconda, the product from which consisted of copper concentrates, lead concentrates, zinc concentrates, and lead-zinc concentrates, valued at $51,101,768, or $34.33 a ton. The crude smelting ore had an average value of $15.92 a ton. No ore was treated by amalgamation or cyanidation, but 1,238,562 tons of old tailings was re-treated by concentration, and 28,310 tons of slag was smelted. Of the total output of ore 84 per cent was classified as copper material.

Divide Creek district (Melrose).—Three deep mines in the Divide Creek district produced 40 tons of ore, valued at $1,837, or $45.92 a ton. A little lead ore was shipped from the Vonka property, silver ore from the Gray Rock mine, and gold ore from the Gold King mine.

German Gulch district.—Three placers in the German Gulch district produced $2,211 in gold and 12 ounces of silver, largely from the Beal placer.

Independence district.—The Black Warrior group, near Rocker, which is north of Butte, produced several lots of silver ore.

Summit Valley or Butte district.—Fifty-four deep mines in the Butte district produced 5,261,260 tons of ore, old tailings, and slag, containing $624,528 in gold, 11,835,643 ounces of silver, 223,042,972 pounds of copper, 25,490,669 pounds of lead, and 141,012,613 pounds of recoverable zinc, valued in all at $54,490,278, or $10.36 a ton. The output consisted of 3,848,415 tons of ore, reduced to 1,488,436 tons of concentrates; 145,973 tons of first-class ore, which was principally copper ore; 1,238,562 tons of old tailings; and 28,310 tons of old slag smelted.

From the beginning of activities in 1882 to the end of 1923 Silver Bow County, which includes the Butte district, has produced gold, silver, copper, lead, and zinc valued at $1,789,956,309, as follows: Gold, $32,973,591; silver, $286,672,454; copper, $1,307,597,300; lead, $10,208,607; and zinc, $152,504,357. These values represent 1,595,097.42 ounces of gold, 387,942,202 ounces of silver, 8,375,449,897 pounds of copper, 163,696,548 pounds of lead, and 1,748,882,224 pounds of recoverable zinc.

The mines of the Anaconda Copper Mining Co.[6] produced 2,814,833 tons of ore and 8,728 tons of precipitates, a total of 2,823,561 tons, in 1923, against 1,990,678 tons in 1922. The concentrator treated 2,892,071 tons of ore, 24,114 tons of slimes from the ponds, 1,147,571 tons of copper tailings, and 60,955 tons of zinc-silver tailings. The copper-reduction works treated for all companies 3,110,348 tons of ore at Anaconda. Of this material 2,735,534 tons of ore was produced by company mines, 345,909 tons was either purchased from or treated for other companies, and 28,904 tons came from the old plants at Anaconda and Butte. The Anaconda works produced 215,107,226 pounds of fine copper, 9,279,770 ounces of silver, and 30,063.53 ounces of gold. Of this production, 200,779,688 pounds of copper, 8,568,607 ounces of silver, and 29,726 ounces of gold were produced for the Anaconda Co. The electrolytic copper refinery at Great Falls produced 205,807,887 pounds of cathodes, most of which were melted into shapes at Great Falls. The total production of copper rods for the year was 110,058,062 pounds. Of this quantity, 42,861,964 pounds was manufactured into wire, of which 12,083,317 pounds was made into strand. The copper-leaching plant at Anaconda, which is fully described in a monthly publication[7] of the Anaconda Copper Mining Co., remained closed throughout the year. The zinc plants at Anaconda and Great Falls treated 289,434 tons of ore and other zinciferous material, of which 47,827 tons was produced by mines of the Anaconda Co., 1,199 tons of material came from the old plants at Butte, and 240,407 tons of ore and concentrates was purchased from other companies. The plant at Great Falls produced 140,363,645 pounds of electrolytic zinc, 4,011,174 pounds of zinc in dross, and residue from which 16,837,089 pounds of lead, 2,376,217 pounds of copper, 3,750,530 ounces of silver, and 6,012.27 ounces of gold were recovered. Dividends amounting to $9,000,000 were paid in 1923 by the Anaconda Co., and the net income for the year was $8,767,814, which added to the balance at the end of 1922 gives a surplus of $70,051,449 after deducting dividends. No statement was made regarding the development work and the ore reserves of the Butte mines. The company's report says:

> At the beginning of the year 1923 there was every prospect that conditions in the copper industry had become stabilized and that it might look forward to a prosperous and satisfactory year. Surplus stocks had been consumed, production was being made at the rate of about 200,000,000 pounds of copper per month, and marked activity prevailed in all lines of consumptive trade. The price reacted favorably, advancing from 14½ cents a pound at the beginning of the year to a high of more than 17 cents per pound in March. After the

[6] Anaconda Copper Mining Co. Ann. Rept. for year ending Dec. 31, 1923.
[7] The Anode, August, 1923.

first quarter there was a notable slackening in industrial activity, followed by a diminished demand for the metal, notwithstanding which, production continued to increase throughout the year, reaching a maximum of more than 240,000,000 pounds in December. The result was an inevitable reduction in the price, which declined gradually as supply exceeded immediate demand, until a low of 12.188 cents a pound was reached in October, the price closing at 12.65 cents at the end of the year. * * *

While the volume of business was the largest in the company's history, the low price for copper that prevailed during the latter half of the year made it impossible to realize earnings commensurate with the business done. Income from sales and royalties amounted to $181,434,447.57. Operating profit and income from investments amounted to $22,412,863.15.

The Butte & Superior Mining Co. operated its mine throughout the year, but the mill was closed in September, after which zinc ore and copper were shipped to Anaconda for milling. The mine was the largest producer of zinc in Montana, the second largest producer of silver, and a notable producer of copper. The company [8] received $3,346,294 from the sale of concentrates and residues in 1923. The cost of mining and milling was $3,032,553, leaving an operating profit of $313,741. After various charges were made for depreciation, development, shutdown expense, and taxes, the net loss, exclusive of a depletion charge, was $31,051. The distribution to stockholders was $290,198, and the surplus $1,889,672. The report continues:

The estimated reserves of developed commercial zinc ore at December 31, 1923, amounted to 384,343 tons, as compared with 507,950 tons at the beginning of the year. In addition to this tonnage there is a fully blocked reserve of some 223,000 tons of lower-grade zinc ore, at least a portion of which can be handled with profit when favorable prices for zinc obtain. * * *

Development of the copper ore body was continued as operating conditions permitted, and it is estimated that the reserves at the end of the year were approximately 250,000 tons, averaging 4.3 per cent copper and 6.37 ounces of silver per ton. Inasmuch as the copper vein has been cut on all levels from the 1,800 to the 2,600, inclusive, it is reasonable to expect that a much larger tonnage exists and will be proven by continuing development work, which is progressing satisfactorily. Copper-ore shipments increased steadily throughout the year to a present rate of approximately 500 tons per day.

Mining and milling operations progressed regularly during the first nine months of the year, but in October suspension of both became inevitable on account of extensive repairs necessary to the No. 3 shaft. Meanwhile it had become evident that the tonnage of zinc ore available for immediate production was not sufficient to supply the mill at economical capacity, and contracts were made for direct sale of the crude ore. Accordingly, when operations were resumed in November the mill remained idle, both zinc ore and copper ore being shipped as mined to custom reduction works. * * *

Sinking and raising of Nos. 2 and 3 shafts was continued, and at the end of the year No. 3 had reached the 2,800-foot level and No. 2 43 feet below that level.

Development work for the year consisted of 13,996 feet of drifts and crosscuts, 4,723 feet of raises and winzes, 46 feet of stations, and 466 feet of shaft sinking and raising, or a total of 19,231 feet. Diamond drilling amounted to a total of 4,204 feet. * * *

The zinc ore produced during the year amounted to a total of 309,803 tons, containing 1,773 ounces of gold, 1,334,566 ounces of silver, 841,303 pounds of copper, 8,321,147 pounds of lead, and 76,407,469 pounds of zinc. * * *

The following tabulation shows the total and average metals contained in ores mined and milled during the first nine months and the total and average contents of all metals in zinc and lead concentrates produced:

[8] Butte & Superior Mining Co. Twelfth Ann. Rept., for year ending Dec. 31, 1923.

Crude ore treated and concentrates produced at Butte-Superior mill in 1923

Ore and product	Quantity	Gold		Silver	
		Total content	Average per ton	Total content	Average per ton
	Short tons	*Ounces*	*Ounces*	*Ounces*	*Ounces*
Crude ore milled	256,853	1,561.0	0.006	1,128,520	4.400
Zinc concentrates	52,965	1,140.0	.022	963,686	18.194
Lead concentrates	1,225	36.0	.029	34,575	28.238

Ore and product	Copper		Lead		Zinc	
	Total content	Average per ton	Total content	Average per ton	Total content	Average per ton
	Pounds	*Per cent*	*Pounds*	*Per cent*	*Pounds*	*Per cent*
Crude ore milled	654,406	0.13	6,987,797	1.360	63,821,752	12.425
Zinc concentrates	484,609	1.46	5,359,422	5.059	59,114,724	55.804
Lead concentrates	9,964	.41	951,100	38.846	469,262	19.162

In addition to these mill products, zinc ore was shipped to Anaconda for milling after October, and 66,074 tons of copper ore containing 299 ounces of gold, 412,185 ounces of silver, and 5,789,019 pounds of copper was marketed.

The Elm Orlu mine was operated the entire year, and its output of silver was unusually large, though the zinc output was less than that of 1919. The mine was second in the production of zinc and third in the production of silver in Montana in 1923. The zinc ore is milled at the Timber Butte plant, south of Butte, which has been used as a custom plant since 1922, and the zinc concentrate is shipped to Great Falls for treatment in the electrolytic plant. Details of operation and figures of production are not published.

The East Butte Copper Mining Co.[9] operated the 500-ton copper smelter and 1,000-ton concentration-flotation plant east of Butte. The mill and smelter treated 91,428 tons of company ore and 131,958 tons of custom ore, producing 692 ounces of gold, 776,705 ounces of silver, and 13,674,932 pounds of copper, a marked increase in the output of silver but no great change in the copper. The gross value of the metals shipped was $2,799,656, including that of 6,109 ounces of gold from the Swissmont property. No dividends were paid in 1923, as the loss from mining operations was $61,665. The price received for copper was 14.40 cents a pound, and the cost was 15 cents. The report continues:

> Ninety four thousand six hundred and sixty-nine tons of 3.25 per cent copper ore were mined during the year, of which 10,381 tons was smelting ore of 5.81 per cent grade, and 84,288 was milling ore of 2.93 per cent grade. * * *
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> Expenditures on development work amounted to $197,111.39, compared with $196,935.93 for 1922 and $153,780.38 for 1921. The progress made consisted of 7,440 lineal feet of drifting and crosscutting, 1,168 lineal feet of raising, and 27,114 cubic feet of ground removed from stations at the new No. 4 shaft.

[9] East Butte Copper Mining Co. Ann. Rept. for year ending Dec. 31, 1923.

It is estimated that development work prosecuted during 1923 to maintain ore reserves developed 140,000 tons of ore, as compared with 95,000 tons mined. Developments on the 1,800 and 2,000 levels have established the downward extension of known ore bodies, and for the next two years at least a good tonnage of better grade of copper ore than was mined during the past year is expected.

The Davis Daly Copper Co. operated the Colorado property, in the center of Butte, and the Hibernia mine, west of Butte. The Colorado mine produced considerable copper ore, which was milled and smelted at the Pittsmont plant, and the Hibernia mine produced lead-zinc ore, which was concentrated at Anaconda. The complete production was not published, but during the first quarter the Colorado mine produced 49,300 tons of ore, 181,838 ounces of silver, and 3,228,542 pounds of copper. From the Hibernia mine 14,004 tons of ore was mined, which produced 187,857 ounces of silver, as well as lead and zinc. Litigation was settled early in 1924, when the property of the company was purchased by the Anaconda Copper Mining Co.

From the North Butte property [10] 157,871 dry tons of ore and precipitates was treated at the smelter at Anaconda. Of the total ore, 1,203 tons, or 0.75 per cent, was first-class; 152,855 tons, or 96.83 per cent, was second-class; and 3,799 tons, or 2.41 per cent, was third-class. The production was 7,891,177 pounds of fine copper, 298,548 ounces of silver, and 544.64 ounces of gold. The report continues as follows:

Mining was continued for the first six months of the year, but production was then suspended because of the unsatisfactory condition of the copper metal market and the cessation of purchases of silver under the Pittman Act by the Government, which caused a drop in the price of that metal.

A total of 4,782 feet of development work was driven during the period of operations.

The loss for 1923 was $192,656, which leaves a surplus of $581,667 from previous earnings.

The Anselmo property produced considerable copper ore and lead-zinc ore, which were milled at Anaconda. The company did more than 1,500 feet of development work and enlarged the shaft from the 600-foot level to the surface. The Emma and Ophir properties, owned by the Butte Copper & Zinc Co., were operated under lease by the Anaconda Copper Mining Co. A large production of silver, lead, and zinc resulted from the concentration of lead-zinc ore milled at Anaconda. The following statement is taken from the company's printed report for 1923:

The developments underground for the year have been very satisfactory. On the 1,100-foot level a very large body of ore, high in zinc, lead, and silver values, was opened up. The shaft has been sunk to the 1,200-foot level, and a crosscut started to cut the vein at that depth. The crosscut is now over 500 feet in length. If the vein when cut discloses the same width and values as were shown on the level above, and it is expected by your engineers that such will be found to be the case, a very considerable tonnage will be added to the ore reserves, thereby, of course, increasing the value of your property.

A large quantity of lead-zinc ore was mined from the Moulton and Poser mines, owned by the Moulton Mining Co. Considerable silver, lead, and zinc were recovered at Great Falls after the ore

[10] North Butte Mining Co. Ann. Rept. for year ending Dec. 31, 1923.

was concentrated in the Timber Butte plant, at Butte. Development work at the Moulton mine consisted of about 2,300 feet of drifts, raises, and crosscuts.

The Butte Ramsdell property was operated under lease through the Colorado mine of the Davis Daly Mining Co. Low-grade copper ore was milled and smelted at the Pittsmont plant.

The Crystal Copper Co. operated the Goldsmith mine throughout the year and made a large expenditure in new equipment. The mine is opened by a vertical shaft 565 feet deep and an inclined winze 270 feet deep below the 600-foot level. The workings were deepened 150 feet during 1923.

Operations were started in June at the Minnie Jane property, west of Butte, by the Butte West Side Mines Co., and more than 500 feet of development work is said to have opened a large body of ore containing gold and silver, with some lead and zinc.

Other properties at Butte that produced more than 100 tons of ore each were the Arctic, Cripple, Salvador, Gallatin, Minnie Irvine, Garibaldi, Non-Consolidated, Amy & St. Clair, and Brilliant mines.

The Tuolumne Copper Co. operated the Main Range mine until June and did development work on the 2,000 and 2,200 foot levels. It plans to continue sinking to the 2,800-foot level early in 1924. The Butte East Slope Mining Co. reports a large quantity of gold-silver ore in reserve for which a milling plant is needed.

SWEET GRASS COUNTY

The Belle Mining Co. did development work on the Granite Mountain mine, and reports considerable ore of good grade in reserve.

TOOLE COUNTY

A small quantity of placer dust was mined from the Cummings and Banner claims, at Gold Butte.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN NEVADA

(MINE REPORT)

By V. C. Heikes [1]

PRODUCTION

The increase in the price of copper, lead, and zinc and the general improvement in mining resulted in an increase in the output of all metals in Nevada in 1923, the combined value of which was greater than in any other year since 1918. Seven mining companies published or reported to the Geological Survey dividends paid in 1923 amounting to $1,162,997.

Mine production of gold, silver, copper, lead, and zinc in Nevada in 1923

	Number of producers	Ore	Gold [a]	Silver [a]	Copper	Lead	Recoverable zinc	Total value
		Short tons		*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
1923	389	4,354,937	$4,223,109	10,614,564	67,204,282	18,156,337	14,166,550	$25,040,349
Increase from 1922	2	2,789,661	925,725	1,994,977	44,071,191	8,767,155	11,547,840	9,334,740
Total, 1904–1923	------	66,516,278	187,099,557	207,167,591	1,064,375,114	256,273,158	189,269,720	559,817,519

[a] Includes placer production.

In Mineral Resources for 1922, Part I, pages 307–309, the source of the different metals by kinds of ore was tabulated by years from 1911 to 1922. The tabulation showed that the dry and siliceous ore produced 89 per cent of the total gold and the siliceous ore and lead ore produced 97 per cent of the total silver. Nearly half the lead was produced from lead ore.

ORE

The quantity of ore sold or treated in Nevada increased more than 178 per cent in 1923. Copper ore was mined in greatest quantity, followed by silver ore. The total values of the ores are as follows:

[1] Valuable assistance in the preparation of this report and the compilation of the statistical tables has been rendered by B. N. Lowry, of the United States Geological Survey.

Dry gold ore, $1,624,442; dry gold and silver ore, $1,889,123; dry silver ore, $7,830,012; copper ore, $10,395,587; lead ore, $1,697,844; zinc ore, $242,502; copper-lead ore, $32,811; lead-zinc ore, $1,245,081. The placer output, valued at $82,947, makes the total for the State $25,040,349.

Ore and metals produced in Nevada in 1923

Source	Number of producers	Ore		Gold		Silver	
		Short tons	Per cent	Fine ounces	Per cent	Fine ounces	Per cent
Dry gold ore	128	142,148	3.26	64,197.59	31.42	186,702	1.76
Dry gold and silver ore	20	551,504	12.66	39,417.45	19.29	1,309,918	12.34
Dry silver ore	110	678,318	15.58	63,579.46	31.12	7,587,436	71.48
Copper ore	14	2,833,908	65.07	29,551.13	14.47	84,568	.80
Lead ore	95	84,764	1.95	2,571.61	1.26	1,238,842	11.67
Zinc ore	3	4,368	.10	4.98		320	
Copper-lead ore	7	330	.01	708.16	.35	13,089	.12
Lead-zinc ore	10	59,597	1.37	320.68	.16	191,906	1.81
Total deep mines		4,354,937	100.00	200,351.06	98.07	10,612,781	99.98
Total placers	35			3,941.83	1.93	1,783	.02
		4,354,937	100.00	204,292.89	100.00	10,614,564	100.00
Increase from 1922		2,789,661		44,781.94		1,994,977	

Source	Copper		Lead		Zinc	
	Pounds	Per cent	Pounds	Per cent	Pounds	Per cent
Dry gold ore	652,081	0.97	691,546	3.81		
Dry gold and silver ore	1,074		14			
Dry silver ore	123,238	.18	3,941,354	21.71		
Copper ore	66,089,635	98.34	2,697	.02		
Lead ore	300,625	.45	8,352,022	46.00		
Zinc ore			40,079	.22	3,519,595	24.84
Copper-lead ore	21,769	.03	60,558	.33		
Lead-zinc ore	15,860	.03	5,068,067	27.91	10,646,955	75.16
	67,204,282	100.00	18,156,337	100.00	14,166,550	100.00
Increase from 1922	44,071,191		8,767,155		11,547,840	

GOLD ORE

The gold ores, largely dry and siliceous, were mined by 128 producers in 1923, compared with 108 producers in 1922. These ores averaged $9.34 in gold and 1.31 ounces of silver to the ton, 0.23 per cent of copper, and 0.24 per cent of lead and were valued at $11.43 a ton. Nye County had the largest number of gold-ore producers—34—who reported 37,009 tons, mainly from the Manhattan district, followed by the Round Mountain district. Elko County, with only 9 producers of gold ore, had the greatest output, 40,434 tons, largely from the Jarbidge district. The largest producer of gold ore was the Elkoro mine, at Jarbidge, followed by the White Caps, at Manhattan; the Consolidated Virginia, in the Comstock district; and the Round Mountain Mining Co., at Round Mountain. At Eureka the old slag dump of the Richmond-Eureka smelter produced 21,094 tons of speiss, the metal content of which (consisting of considerable gold as well as silver, copper, and lead) is included in this report.

Content of dry gold ore sold or treated in Nevada in 1923

County	Ore	Gold	Silver	Copper	Lead
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Churchill	6	87.26	178		
Clark	840	287.63	230	30	2,770
Douglas	53	53.76	25		
Elko	40,434	16,577.53	34,404	412	
Esmeralda	4,778	5,646.54	5,048	2,263	5,950
Eureka	20,956	3,575.13	49,172	643,652	677,598
Humboldt	24	260.90	369		
Lander	193	229.43	1,353	5,491	701
Lyon	899	811.54	813		
Mineral	260	537.04	3,126	220	4,478
Nye	37,009	23,943.92	6,824		
Ormsby	50	17.92	21		
Pershing	2,238	3,946.23	3,986		
Storey	34,205	8,063.31	80,934		
Washoe	127	127.52	67		
White Pine	76	31.93	152	13	49
	142,148	64,197.59	186,702	652,081	691,546

GOLD AND SILVER ORES

Gold and silver ores were mined in 10 counties by 20 producers. The average of the output was $1.48 in gold and 2.38 ounces of silver to the ton. Six producers reported 549,992 tons from Storey County, mined in the Comstock district.

Content of dry gold and silver ore sold or treated in Nevada in 1923

County	Ore	Gold	Silver	Copper	Lead
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Clark	160	80.83	2,283		
Douglas	1	.12	3		
Elko	384	118.00	3,726		
Esmeralda	138	160.28	4,074		
Eureka	15	20.30	323		
Humboldt	56	313.74	8,833	162	14
Lyon	300	19.71	475		
Mineral	375	406.86	12,907		
Nye	83	74.83	2,178		
Storey	549,992	38,222.78	1,275,116	912	
	551,504	39,417.45	1,309,918	1,074	14

SILVER ORE

The output of siliceous silver ore was mined by 110 producers and averaged $1.94 in gold and 11.19 ounces of silver to the ton, 0.01 per cent of copper, and 0.29 per cent of lead. The Tonopah district, in Nye County, was the largest producer of silver ore and was credited with 371,885 tons, produced from 14 properties.

Content of dry silver ore sold or treated in Nevada in 1923

County	Ore	Gold	Silver	Copper	Lead
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Churchill	993	24.67	27,999	3	423
Elko	2	3.00	381	----	----
Esmeralda	17,082	2,407.39	447,395	----	2,453
Eureka	43	17.03	3,653	1,229	815
Humboldt	304	17.45	14,369	1,241	1,971
Lander	14,540	599.70	229,656	19,891	448,807
Lincoln	70,223	2,929.07	418,445	98,832	3,477,746
Lyon	114	63.22	3,076	----	----
Mineral	98,092	1,430.86	476,532	----	490
Nye	378,512	53,573.83	5,210,621	62	----
Ormsby	5	.54	293	46	78
Pershing	97,395	2,440.26	722,921	88	----
Storey	40	----	1,509	----	----
Washoe	311	28.04	8,815	183	7,559
White Pine	662	44.40	21,771	1,663	1,012
	678,318	63,579.46	7,587,436	123,238	3,941,354

COPPER ORE

There were 14 producers of copper ore in 1923. The ore averaged 22 cents in gold and 0.03 ounce of silver to the ton and 1.17 per cent of copper and was valued at $3.67 a ton. The Nevada Consolidated Copper Co., in the Robinson district, White Pine County, was the principal producer.

Content of copper ore sold or treated in Nevada in 1923

County	Ore	Gold	Silver	Copper	Lead
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Clark	30	5.00	493	8,086	1,112
Elko	88	4.98	1,088	28,069	1,397
Lander	141	.04	26	15,814	15
Lincoln	564	7.34	5,242	65,599	----
Lyon	150	----	3	33,913	----
Washoe	154	33.39	857	11,792	173
White Pine	2,832,781	29,500.38	76,859	65,926,362	----
	2,833,908	29,551.13	84,568	66,089,635	2,697

LEAD ORE AND COPPER-LEAD ORE

Lead ore was produced in Nevada at 95 mines in 1923, compared with 88 in 1922. The average content of the ore was 63 cents in gold and 14.62 ounces of silver to the ton, 0.18 per cent of copper, and 4.93 per cent of lead, and the ore was valued at $20.03 a ton.

The output of copper-lead ore was reported by seven producers. The average content was $44.36 in gold and 39.66 ounces of silver to the ton, 3.30 per cent of copper, and 9.18 per cent of lead, and the average value was $99.43 a ton.

Content of lead ore sold or treated in Nevada in 1923

County	Ore	Gold	Silver	Copper	Lead
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Churchill	105	2.84	2,424	171	82,379
Clark	594	14.05	3,279	1,767	479,427
Douglas	3	.03	131		1,171
Elko	2,568	166.96	60,183	7,013	1,119,565
Esmeralda	76	11.73	2,007	363	44,137
Eureka	6,060	536.59	34,307	1,989	720,516
Humboldt	20	.69	629		10,830
Lander	38,404	174.49	656,780	48,830	306,303
Lincoln	13,938	1,034.63	169,689	184,035	2,311,572
Mineral	383	478.87	40,110	688	93,268
Nye	135	38.09	11,794	510	18,681
Pershing	150	25.51	4,289	122	48,549
Washoe	11,719	21.43	211,072	44,642	732,751
White Pine	10,609	65.70	42,148	10,495	2,382,873
	84,764	2,571.61	1,238,842	300,625	8,352,022

Content of copper-lead ore sold or treated in Nevada in 1923

County	Ore	Gold	Silver	Copper	Lead
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Clark	271	705.54	2,068	14,122	41,596
Elko	36	.42	731	5,482	13,503
Lander	8		8,705	80	2,799
Mineral	13	2.14	1,484	1,174	1,894
White Pine	2	.06	101	187	766
	330	708.16	13,089	21,769	60,558

ZINC ORE AND LEAD-ZINC ORE

The output of zinc ore was reported by three producers in the Yellow Pine district, Clark County, and the Robinson district, White Pine County.

Lead-zinc ore was produced from 10 mines in the Yellow Pine district, Clark County; the Pioche district, Lincoln County; and the Bell district, Mineral County. The ore contained an average of 11 cents in gold and 3.22 ounces of silver to the ton, 0.01 per cent of copper, 4.25 per cent of lead, and 8.93 per cent of zinc and was valued at $20.89 a ton. Most of the lead-zinc ore came from the Simon mine, in Mineral County.

Content of zinc ore sold or treated in Nevada in 1923

County	Ore	Gold	Silver	Lead	*Zinc*
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Clark	3,794			3,979	3,184,643
White Pine	574	4.98	320	36,100	334,952
	4,368	4.98	320	40,079	3,519,595

Content of lead-zinc ore sold or treated in Nevada in 1923

County	Ore	Gold	Silver	Copper	Lead	Zinc
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Clark	10,371		28,316		990,880	5,570,784
Lincoln	8,420	248.00	62,400		1,053,141	2,756,118
Mineral	40,806	72.68	101,190	15,860	3,024,046	2,320,053
	59,597	320.68	191,906	15,860	5,068,067	10,646,955

METALLURGIC INDUSTRY

Sixty-five milling plants were reported in operation in Nevada in 1923. Of these 22 used the amalgamation process, 7 concentration (5 of which had flotation units), 28 cyanidation, 1 amalgamation and cyanidation, 3 concentration and cyanidation, and 4 amalgamation and concentration.

About 690 pounds of mercury was purchased for use in amalgamation, and 3,200,209 pounds of potassium and sodium cyanide was used.

Gold and silver produced from Nevada mills in 1923

County	Ore (short tons)	Bullion (fine ounces) recovered from ore by—				Total value
		Amalgamation		Cyanidation		
		Gold	Silver	Gold	Silver	
Churchill	972	4.69	4	6.35	24,591	$20,396
Clark	[a] 500	139.36	66	[b] 211.16	[b] 2,409	9,276
Douglas	54	53.76	25	.12	3	1,137
Elko	40,797	111.01	90	16,513.45	37,957	374,857
Esmeralda	[c] 20,937	788.85	413	6,824.58	449,475	526,292
Eureka	15			20.30	323	685
Humboldt	[d] 51	125.81	103			2,685
Lander	[e] 9,260	9.44	3	239.28	132,407	113,717
Lincoln	550			6.33	8,254	6,899
Lyon	936	717.00	345	[f] 135.84	[f] 2,905	20,295
Mineral	[g] 98,396	324.30	93	1,525.47	473,427	426,524
Nye	371,204	9,653.29	5,259	[h] 67,343.77	[h] 5,201,442	5,861,166
Ormsby				[i] 17.92	[i] 21	387
Pershing	[j] 99,421	3,579.38	2,110	2,712.20	708,928	713,109
Storey	[k] 583,266	1,994.50	2,219	[l] 43,510.67	[l] 1,338,931	2,040,418
Washoe	130	89.40	35	.53	164	2,022
White Pine	[m] 76	24.00	11	.79	4,714	4,387
	1,226,565	17,614.79	10,776	139,068.76	8,385,951	10,124,252

[a] Also yielded 2 tons of concentrate.
[b] Includes bullion from 500 tons of old tailings.
[c] Also yielded 3 tons of concentrate.
[d] Also yielded 13 tons of concentrate.
[e] Also yielded 211 tons of concentrate.
[f] Includes bullion from 300 tons of old tailings.
[g] Also yielded 7 tons of concentrate.
[h] Includes bullion from 43,502 tons of old tailings.
[i] Bullion from 50 tons of old tailings.
[j] Also yielded 85 tons of concentrate.
[k] Also yielded 49 tons of concentrate.
[l] Includes bullion from 440 tons of old tailings.
[m] Also yielded 1 ton of concentrate.

The output of milling ores was 4,050,072 tons, of which 1,226,565 tons was treated by amalgamation or cyanidation and 2,823,507 tons by concentration followed by smelting. The 1,201,211 tons of ore and 44,792 tons of tailings treated by cyanidation contained an average of $2.31 in gold and 6.73 ounces of silver to the ton. The ores amalgamated (25,354 tons) yielded bullion averaging $14.36

in gold and 0.43 ounce of silver to the ton of ore treated. Nearly 65 per cent of the total ore was of concentrating grade and produced concentrate that was valued at $34.67 a ton.

Mine production of gold, silver, copper, lead, and zinc from Nevada concentrates in 1923

By counties

County	Ore to concentrating mills	Concentrates	Gold	Silver	Copper	Lead	Recoverable zinc	Total value of concentrates
	Short tons	*Short tons*	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
Clark	6,510	5,388	17.92	28,354	30	404,269	3,369,793	$281,070
Esmeralda		3	5.91	2,251		2,453		2,140
Eureka	4,737	331	13.92	7,383	316	386,435		33,439
Humboldt		13	3.30	414	72			419
Lander	38,150	2,515	90.97	692,734	49,707	307,491		598,754
Mineral	40,806	5,428	77.15	101,271	15,860	3,028,524	2,320,053	456,728
Nye	12	2	29.28	54				649
Pershing		85	15.59	11,060				9,391
Storey	264	93	302.28	9,024	912			13,783
Washoe	10,974	1,225	16.75	208,744	44,232	715,580		228,109
White Pine	2,722,054	283,595	28,770.71	72,903	54,943,730			8,731,251
	2,823,507	298,678	29,343.78	1,134,192	55,054,859	4,844,752	5,689,846	10,355,733

By kinds of concentrates

Dry and siliceous	194	352.76	20,607	984			$24,335
Copper	283,594	28,768.40	72,848	54,943,730			8,731,159
Lead	6,802	188.47	1,021,431	106,102	4,529,964		1,174,164
Zinc	8,088	34.15	19,306	4,043	314,788	5,689,846	426,075

Average content

Kind of concentrates	Concentrates	Gold	Silver	Copper	Lead	Recoverable zinc	Total value
	Short tons	*Fine ounces per ton*	*Fine ounces per ton*	*Per cent*	*Per cent*	*Per cent*	
Dry and siliceous	194	1.82	106.22	0.25			$125.44
Copper	283,594	.10	.26	9.69			30.79
Lead	6,802	.03	150.18	.78	33.30		172.62
Zinc	8,088		2.39	.02	1.95	35.17	52.68
	298,678	.10	3.80	9.22	.81	.95	34.67

The oxidized lead ore, largely carbonates, of smelting grade increased from 17,707 tons in 1922 to 21,850 tons in 1923 and averaged $1.09 in gold, 10.86 ounces of silver, 8.66 pounds of copper, 224.01 pounds of lead, and $26.95 in total value to the ton. The sulphide lead ores of smelting grade averaged $6.68 in gold, 32.25 ounces of silver, 2.63 pounds of copper, 733.82 pounds of lead, and $84.88 in total value to the ton. The production of copper-lead ores increased from 102 tons to 330 tons, nearly all of which was oxidized or carbonate ore shipped directly to smelters. The oxidized ore (310 tons) averaged $47.07 in gold, 36.98 ounces of silver, 61.57 pounds of copper, 185.47 pounds of lead, and $99.43 in total value to the ton. Of the lead-zinc ore produced (59,597 tons) only 12,281 tons was first-class shipping ore. All the zinc ore produced was shipped directly to the smelter.

Mine production of gold, silver, copper, lead, and zinc from Nevada crude ore shipped to smelters in 1923

By counties

County	Ore	Gold	Silver	Copper	Lead	Recoverable zinc	Total value
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
Churchill	132	103.73	6,006	174	82,802		$12,891
Clark	8,550	724.61	5,840	23,975	1,115,495	5,385,634	467,600
Douglas	3	.03	131		1,171		190
Elko	2,708	246.29	62,324	39,467	1,133,296		141,330
Esmeralda	1,137	606.60	6,385	2,626	50,087		21,668
Eureka	1,366	539.70	30,577	2,902	334,896		60,099
Humboldt	353	463.67	23,683	1,331	12,815		30,098
Lander	5,876	663.97	71,376	41,123	451,134		109,877
Lincoln	56,533	570.89	272,741	257,235	4,543,537	2,756,118	778,726
Lyon	77	41.63	1,114				1,774
Mineral	727	1,001.53	60,558	2,082	95,652		77,362
Nye	1,021	604.33	24,662	572	18,681		34,108
Ormsby	5	.54	293	46	78		263
Pershing	205	101.75	8,694	210	48,549		12,661
Storey	267	478.64	7,385				15,950
Washoe	507	103.70	11,868	12,385	24,903		15,440
White Pine	122,574	851.94	63,723	10,994,990	2,420,800	334,952	1,878,360
	202,041	7,103.55	657,360	11,379,118	10,333,896	8,476,704	3,658,397

By kinds of ore

Dry and siliceous	49,862	3,675.27	279,350	53,227	2,481,375		$486,562
Copper	111,704	782.72	11,717	11,111,992	2,697		1,659,440
Lead	23,503	1,684.52	290,626	193,639	6,107,834		729,148
Zinc	4,368	5.00	320		40,079	3,519,595	242,504
Copper-lead	323	708.04	12,947	20,260	59,389		32,388
Lead-zinc	12,281	248.00	62,400		1,642,522	4,957,109	508,355

Average content

Kind of ore	Ore	Gold	Silver	Copper	Lead	Recoverable zinc	Total value
	Short tons	*Fine ounces per ton*	*Fine ounces per ton*	*Per cent*	*Per cent*	*Per cent*	
Dry and siliceous	49,862	0.07	5.60	0.05	2.49		$9.76
Copper:							
Oxidized	22,856	.01	.37	2.71			8.42
Sulphide	88,848	.01	.04	5.56			16.51
Lead:							
Oxidized	21,850	.05	10.86	.43	11.20		26.95
Sulphide	1,653	.32	32.25	.13	36.69		84.88
Zinc:							
Oxidized	4,178		.08		.43	40.56	55.85
Sulphide	190				1.05	34.31	48.13
Copper-lead:							
Oxidized	310	2.28	36.98	3.08	9.27		99.43
Sulphide	13	.01	114.15	4.52	7.28		120.46
Lead-zinc:							
Oxidized	3,677				7.38	28.81	49.52
Sulphide	8,604	.03	7.25		6.39	16.49	37.92
	202,041	.04	3.25	2.82	2.56	2.10	18.11

GOLD

On account of the resumption of the mining of copper ore and an increase in the quantity of gold and silver ore, the output of gold increased from $3,297,384 in 1922 to $4,223,109 in 1923. Ore was treated by amalgamation in 14 counties and by cyanidation in 16 counties. By these two methods of treatment $3,238,936 in gold was produced from 1,226,565 tons of ore and 44,792 tons of old tailings.

A large part of the placer gold in 1923 was obtained by hydraulic work in the Round Mountain district, Nye County, and by drift mining at Manhattan and in the Battle Mountain district, Lander County.

Nine producers supplied nearly 74 per cent of the total gold in 1923. Their properties, which yielded more than 8,000 ounces each, were the United Comstock, in the Comstock district; the Nevada Consolidated, at Ely; the Tonopah Extension, at Tonopah; the Elkoro, at Jarbidge; the White Caps, at Manhattan; the West End, Tonopah, and Tonopah Belmont, at Tonopah; and the Round Mountain, at Round Mountain.

SILVER

The quantity of silver increased 23 per cent in 1923, but the value only 1 per cent, owing to the decrease in price. There was a marked decline in the production of silver in the Tonopah district after the expiration of the Pittman Act, but the Comstock district increased its output. Milling plants in Nye County were credited with 5,206,701 ounces, most of which (5,201,442 ounces) was recovered by cyanidation from ores treated principally in the Tonopah district. In the Comstock district, Storey County, 1,338,931 ounces of silver was recovered by cyanidation, and in the Rochester district, Pershing County, 662,181 ounces of silver was recovered by the same process. Concentrates from milling plants yielded 1,134,192 ounces of silver, against 398,112 ounces in 1922. Lead concentrates contained 1,021,431 ounces of silver, or an average per ton of 150.18 ounces, against 331,681 ounces, or an average of 102.80 ounces, in 1922.

Nearly 62 per cent of the total silver was produced from the Tonopah Extension, at Tonopah; the United Comstock, in the Comstock district; the West End Consolidated, Tonopah Mining, and Tonopah Belmont, all at Tonopah; and the Betty O'Neal, near Battle Mountain.

COPPER

The mine production of copper in Nevada in 1923 increased $6,756,062 in value. The mine of the Nevada Consolidated Co., at Ely, in White Pine County, made the largest output, producing copper at the average rate of about 5,000,000 pounds a month. This company also rebuilt its concentration plant. Shipments of ore to the smelter at McGill from the property of the Consolidated Copper mines were resumed in June, and shipments of first-class copper ore were made from the Boston-Ely mine.

LEAD

The mine production of lead in Nevada in 1923 increased more than 93 per cent. More than 26 per cent of the lead was derived from concentrates of milling ore, and nearly 57 per cent from crude ore shipped directly to smelters. Lead concentrates (carbonates and sulphides) shipped to smelters contained 4,529,964 pounds of lead, against 2,908,292 pounds in 1922, and averaged 33.30 per cent of lead, against 44.80 per cent in 1922. The total crude ore of shipping grade contained 10,333,896 pounds of lead, against 4,763,566 pounds in 1922. Oxidized lead ore shipped to smelters contained 4,894,825 pounds of lead, and sulphide ore 1,213,009 pounds, against

3,529,779 pounds and 931,149 pounds, respectively, in 1922. Copper-lead ore of shipping grade, nearly all of which was oxidized, produced 59,389 pounds of lead. The oxidized lead-zinc ore of smelting grade produced 542,929 pounds of lead, and the sulphide ore 1,099,593 pounds.

More than 61 per cent of the lead came from six mines. The leading producer was the Simon silver-lead mine, in the Bell district, Mineral County; followed by the Prince Consolidated and Virginia Louise, Lincoln County; the Ward, in the Ward district, White Pine County; and the Bristol Silver and Combined Metals, near Pioche.

ZINC

The Yellowpine district, Clark County, made the largest part of the zinc output and was followed in order by the Pioche district, Lincoln County; the Bell district, Mineral County; and the Robinson district, White Pine County.

MINING INDUSTRY

Purchases of silver under the Pittman Act were discontinued May 29, 1923, after which the price averaged about 64 cents an ounce. While silver sold for $1 an ounce several milling plants were constructed, and production was kept at a high peak. After purchase under the act ceased some mines, having been depleted of the higher-grade ore, found no profit in operating. This condition and the status of mining in Nevada[2] are summarized in an interesting review, as follows:

> Nevada produced 16,090,083 ounces of silver in 1913. Since that year silver production decreased to 6,863,580 ounces in 1919. In 1922 it reached 8,619,587 ounces. On the basis of 7,000,000 ounces, the gross income of the Nevada miners from silver will be reduced by $2,524,830. Needless to say, this new status has affected Nevada mining. During the five-year interval of high silver prices wages increased as well as the cost of supplies and machinery. Silver averaged about 60 cents in 1913; on the basis of commodity prices 63-cent silver now has a purchasing power of about 42 cents, compared to its purchasing power of 60 cents in 1913. To obtain a gross income of $7,000,000 per year, Nevada silver miners would have to produce about 11,000,000 ounces of silver, or an increase of 57 per cent on the basis of 7,000,000 ounces annual production. In 1918 Nevada produced 10,000,599 ounces of silver. Since then the silver production declined, but was accelerated in 1922 and early in 1923 through the influence of the Pittman Act. It is highly improbable that an annual production of 11,000,000 ounces will be made.
>
> In 1921 the tonnage of siliceous silver ore mined by 133 producers was 543,345; siliceous gold ore to the amount of 63,850 tons was mined by 122 producers, and 60,365 tons of gold and silver ore was mined by 21 producers in the same year. The bulk of precious-metal ore therefore comes from the silver mines. The siliceous silver ores averaged $2.42 in gold and 11.34 ounces of silver per ton. The comparative values at $1 and 63 cents per ounce silver are $13.76 and $9.56, respectively; the difference in value is $4.20 per ton. As an example, the Tonopah Belmont Development Co. in 1921 recovered $14.07 per ton at a cost of $9.86 per ton and an operating margin of $4.21 per ton. Thus the present price of silver would have absorbed the operating margin.

Until July considerable siliceous ore containing principally silver and some gold was treated at Tonopah at reasonable custom rates. Some of the ore contained lead, which was paid for as of value in the leaching operations, but none of this lead was saved. The To-

[2] Status of Nevada mining: Eng. and Min. Jour.-Press, Oct. 20, 1923.

nopah Belmont mill, receiving custom ores for treatment by cyanidation, ceased operations, as many silver producers had been obliged to close their mines. A new demand for siliceous ore was created when the Mammoth Copper smelter, at Kennett, Calif., started. On August 15 two furnaces were blown in, after being idle since May, 1919. About 700 tons of ore charge was treated daily, and preparations were made for starting a third furnace after the first of the new year.

Most of the cyanide mills operated under an arrangement with the Nevada Mine Operators Association for a supply of cyanide. The American Cyanamid Co. contracted to supply the 1924 demand, estimated at 1,050 tons, at a price based on 100 per cent product. Because of the smaller number of mills operating the quantity ordered is 500 tons less than was provided for the year 1923.

In the camps where lead is one of the chief metals the operators found themselves in a good position by reason of the increased price of lead, even though the price of silver had declined.

Efforts were being made to obtain a readjustment of ore freight rates in favor of the Thompson smelter, near Wabuska, Lyon County, owned by the Mason Valley Mines Co. This company recently acquired the Bluestone mines and by other activities was judged to be getting ready for production.

Wages of all classes of labor were advanced in copper districts, especially at Ely, where on March 11 an increase of 50 cents a shift was made. The Nevada Consolidated, near Ely, enlarged its concentrator and smelter and averaged about 6,000,000 pounds of copper a month.

In Mineral County a reduction of 9 per cent on rates for the county's electric power became effective October 1. The only two mining companies in the county using a substantial amount of power were the Candelaria Mines Co. and the Simon Silver-Lead Mines Co.

Freight rates on ore and concentrates from railroad shipping points in Nevada to Salt Lake smelters were tabulated in a recent article[3] as follows:

Freight rates on ores and concentrates from railroad shipping points in Nevada to Salt Lake smelters

Shipping point and destination	Value of ores and concentrates per ton									
	$10	$20	$30	$40	$50	$60	$70	$80	$90	$100
	Rate per ton									
To Garfield, Utah, from—										
Cherry Creek [a]	------	$4.60	$5.10	$5.60	$6.10	$6.60	$7.10	$7.60	$8.10	$8.60
Cherry Creek [b]	------	3.20	3.90	4.60	5.30	6.00	6.70	7.40	------	------
To Salt Lake smelters from—										
Goldfield	------	5.10	5.80	6.50	7.20	7.90	8.60	9.30	10.00	10.70
Battle Mountain [c]	------	3.20	3.80	4.40	5.00	5.60	6.20	6.80	7.40	8.00
Palisade [c]	------	3.20	3.80	4.40	5.00	5.60	6.20	6.80	7.40	8.00
Mina [c]	------	3.60	4.30	5.00	5.70	6.40	7.10	7.80	8.50	9.20
Lovelock [c]	------	3.20	3.90	4.60	5.30	6.00	6.70	7.40	8.10	8.80
Golconda [c]	------	3.20	3.90	4.60	5.30	6.00	6.70	7.40	8.10	8.80
Hazen [c]	------	3.20	3.90	4.60	5.30	6.00	6.70	7.40	8.10	8.80
Tonopah	------	5.10	5.80	6.50	7.20	7.90	8.60	9.30	10.00	10.70
Rogerson (Idaho)	$3.00	3.50	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50

[a] Minimum weight, 40,000 pounds.
[b] Minimum weight, 80,000 pounds.
[c] Minimum weight, marked capacity of car used but not less than 80,000 pounds.

[3] Eng. and Min Jour.-Press, Aug. 11, 1923, p. 259.

REVIEW BY COUNTIES

GENERAL FEATURES

Mine production of gold, silver, copper, lead, and zinc in Nevada in 1923, by counties

County	Gold					Silver	
	Placers		Deep mines		Total value	Fine ounces	Value
	Fine ounces	Value	Fine ounces	Value			
Churchill	12.24	$253	114.74	$2,372	$2,625	30,604	$25,095
Clark			1,093.03	22,595	22,595	36,669	30,069
Douglas	7.06	146	53.94	1,115	1,261	160	131
Elko			16,870.88	348,752	348,752	100,513	82,421
Esmeralda	44.55	921	8,225.93	170,045	170,966	458,530	375,995
Eureka	60.37	1,248	4,149.08	85,769	87,017	87,459	71,716
Humboldt			592.79	12,254	12,254	24,200	19,844
Lander	320.20	6,619	1,003.63	20,747	27,366	896,564	735,182
Lincoln			4,219.03	87,215	87,215	655,776	537,736
Lyon	1,540.02	31,835	894.45	18,490	50,325	5,037	4,130
Mineral	2.03	42	2,928.48	60,537	60,579	635,350	520,987
Nye	1,835.83	37,950	77,630.70	1,604,769	1,642,719	5,232,433	4,290,595
Ormsby			18.48	382	382	314	258
Pershing	49.68	1,027	6,412.01	132,548	133,575	731,222	599,602
Storey			46,286.07	956,818	956,818	1,357,559	1,113,198
Washoe			210.38	4,349	4,349	220,811	181,065
White Pine	69.85	1,444	29,647.44	612,867	614,311	141,363	115,918
	3,941.83	81,485	200,351.06	4,141,624	4,223,109	10,614,564	8,703,942

County	Copper		Lead		Recoverable zinc		Total value
	Pounds	Value	Pounds	Value	Pounds	Value	
Churchill	174	$26	82,802	$5,796			$33,542
Clark	24,005	3,529	1,519,764	106,384	8,755,427	$595,369	757,946
Douglas			1,171	82			1,474
Elko	40,976	6,023	1,134,465	79,413			516,609
Esmeralda	2,626	386	52,540	3,678			551,025
Eureka	646,870	95,090	1,398,929	97,925			351,748
Humboldt	1,403	206	12,815	897			33,201
Lander	90,830	13,352	758,625	53,104			829,004
Lincoln	348,466	51,224	6,842,459	478,972	2,756,118	187,416	1,342,563
Lyon	33,913	4,985					59,440
Mineral	17,942	2,637	3,124,176	218,692	2,320,053	157,763	960,658
Nye	572	84	18,681	1,308			5,934,706
Ormsby	46	7	78	5			652
Pershing	210	31	48,549	3,398			736,606
Storey	912	134					2,070,150
Washoe	56,617	8,323	740,483	51,834			245,571
White Pine	65,938,720	9,692,992	2,420,800	169,456	334,952	22,777	10,615,454
	67,204,282	9,879,029	18,156,337	1,270,944	14,166,550	963,325	25,040,349

Production from deep mines in Nevada in 1922 and 1923, by counties

County	Ore sold or treated, 1923 (short tons)		Number of deep mines producing		Average value per ton[a]		Average value per ton in gold and silver	
	Total	Increase or decrease	1922	1923	1922	1923	1922	1923
Churchill	1,104	−1,165	8	11	$19.04	$30.15	$19.03	$24.88
Clark	16,060	+12,757	18	20	35.89	47.19	13.98	3.28
Douglas	57	+22	3	5	15.86	23.28	15.86	21.84
Elko	43,512	−5,338	30	28	14.76	11.87	13.81	9.91
Esmeralda	22,074	−6,488	31	27	33.87	24.92	33.78	24.74
Eureka	27,074	+22,633	20	15	29.51	12.95	20.05	5.82
Humboldt	[b]404	+115	15	17	105.90	82.18	100.54	79.45
Lander	53,286	+46,926	10	16	15.43	15.43	13.97	14.19
Lincoln	93,145	+54,614	17	10	18.38	14.41	12.16	6.71
Lyon	1,463	−1,378	12	11	7.11	18.49	7.11	15.09
Mineral	139,929	+106,651	38	35	11.95	6.86	6.44	4.16
Nye	415,739	−80,383	60	65	14.21	14.18	14.18	14.18
Ormsby	55	+55	----	3	----	11.85	----	11.64
Pershing	99,783	−19,707	30	27	7.99	7.37	7.94	7.34
Storey	584,237	+445,485	15	21	4.53	3.54	4.53	3.54
Washoe	12,311	+3,663	12	17	32.93	19.95	26.78	15.06
White Pine	2,844,704	+2,211,199	26	26	5.23	3.73	.30	.26
	4,354,937	+2,789,661	345	354	9.88	5.73	7.46	2.95

[a] Placer product excluded. [b] Includes rich concentrated ore.

Production from placer mines in Nevada in 1922 and 1923, by counties

County	1922						1923					
	Mines			Gold	Silver (fine ounces)	Total value	Mines			Gold	Silver (fine ounces)	Total value
	Hydraulic	Drift	Dredge				Hydraulic	Drift	Dredge			
Churchill	----	----	----	----	----	----	1	----	----	$253	3	$255
Douglas	1	----	----	$85	1	$86	1	----	----	146	1	147
Elko	3	----	----	398	7	405	----	----	----	----	----	----
Esmeralda	----	----	----	----	----	----	3	----	----	921	6	926
Eureka	1	----	----	1,240	4	1,244	2	----	----	1,248	4	1,251
Humboldt	2	----	----	272	5	277	----	----	----	----	----	----
Lander	7	1	----	59,695	429	60,124	5	----	----	6,619	44	6,655
Lyon	1	----	1	110,299	2,563	112,862	----	----	1	31,835	670	32,385
Mineral	1	----	----	45	8	53	1	----	----	42	1	43
Nye	[a]15	3	----	62,846	1,650	64,496	[a]15	1	----	37,950	1,016	38,783
Pershing	----	1	----	357	3	360	4	----	----	1,027	26	1,048
Washoe	1	----	----	69	1	70	----	----	----	----	----	----
White Pine	4	----	----	4,536	39	4,575	1	----	----	1,444	12	1,454
	36	5	1	239,842	4,710	244,552	33	1	1	81,485	1,783	82,947

[a] Part of operations drifting and sluicing

CHURCHILL COUNTY

Broken Hills district.—From mining operations of five properties in the Broken Hills district 972 tons of ore was produced, containing $1,815 in gold, 24,853 ounces of silver, and 1,507 pounds of lead, valued in all at $22,300. Most of the ore was of milling grade and came from the property of the Broken Hills Silver Corporation. The Highway mine produced a small lot of high-grade silver ore carrying copper.

Fairview district.—Several small lots of lead ore containing silver were shipped from the Chalk Mountain Silver property. The mine is opened by a shaft 120 feet deep and has 500 feet of drifts.

Holy Cross district.—The Last Hope property produced several small lots of high-grade silver ore containing a little gold and some lead.

Sandsprings district.—Three producers in the Sandsprings district produced 19 tons of ore valued at $1,019 in gold and silver. The Dan Tucker, Double Ender, and Sylvanite groups of claims were developed.

CLARK COUNTY

In Clark County there were 20 producers, or 2 more than in 1922, and the production of ore and of all the metals except gold increased—ore from 3,303 to 16,060 tons, silver from 11,682 to 36,669 fine ounces, copper from 12,899 to 24,005 pounds, lead from 360,500 to 1,519,764 pounds, zinc from 891,174 to 8,755,427 pounds, and total value from $118,532 to $757,946. The gold decreased from $34,485 to $22,595.

Eldorado Canyon district.—A general clean-up of the Techatticup property by lessees resulted in the shipment of silver bullion containing gold.

Searchlight district.—Six producers of ore in the Searchlight district reported the output of 1,142 tons, containing $20,815 in gold, 2,708 ounces of silver, 22,150 pounds of copper, and 47,651 pounds of lead, valued in all at $29,628. About half the ore and 500 tons of old tailings were milled and produced gold and silver bullion and some concentrate. The bullion contained 269.69 ounces of gold and 192 ounces of silver. Crude ore shipped to the smelter amounted to 302 tons, containing 719.35 ounces of gold, 2,478 ounces of silver, 22,120 pounds of copper, and 44,881 pounds of lead. The most activity was shown at the Duplex property, where the old mill was remodeled for a leaching plant to receive custom ore. Some ore was shipped from the Quartette mine, and lessees shipped ore from the dump of the Peerless mine.

Yellowpine district.—Thirteen producers in the Yellowpine district reported the output of 14,758 tons of ore, containing $109 in gold, 31,678 ounces of silver, 1,855 pounds of copper, 1,472,113 pounds of lead, and 8,755,427 pounds of zinc, valued altogether at $724,775. Most of this output was shipped directly to smelters and amounted to 8,248 tons, containing gold, silver, copper, lead, and zinc. The remainder of the ore produced—6,510 tons—was milled, and 5,386 tons of concentrate containing lead and zinc was sold to zinc plants in Eastern States and silver-lead concentrate to smelters in Utah. The Yellowpine Mining Co. produced most of the ore and concentrate. Smaller lots of lead-zinc ore were produced from the Lead Point, Bullion, Anchor, Milford & Addison, Ingomar, Fighting Chance, Plomosa, Maiden Rock, May Kirby, Potosi, and Tiffen properties.

In 1923 the Yellowpine Mining Co.[4] added to its holdings by purchasing the control of the adjoining Prairie Flower property. More than 11,000 tons of ore was mined at a cost of $3.60 a ton,

[4] Yellowpine Mining Co. Ann. Rept. for year ending Dec. 31, 1923.

and 3,401 tons of ore was treated at the mill at Goodsprings and cost $2.36 a ton. A separation of lead-silver concentrate and zinc concentrate was made. The zinc concentrate assayed 40.8 per cent of zinc, and the lead concentrate contained 70.2 ounces of silver to the ton and 52.4 per cent of lead. During eight months' operation the calcining plant treated 2,669 tons of mill concentrate, 3,541 tons of slimes, and 4,458 tons of crude zinc ore, at a cost of $1.62 a ton. New railroad track was laid from the base of Root Mountain to the new ore bins, and repairs of the railroad were made between Goodsprings and Jean. The average cost of transporting 13,750 tons of ore and concentrate was $2.01 a ton. The metals recovered from the ore, concentrates, and slimes were 28,316 ounces of silver, 8,318,627 pounds of zinc, and 863,037 pounds of lead, for which $277,791.90 was received, according to the company's report. Dividends paid to stockholders in 1923 amounted to $90,000, or a total to date of $2,724,000.

DOUGLAS COUNTY

Gardnerville district.—In testing the ore of the Emerald mine a small lot of gold bullion was recovered.

Mount Siegel district.—The Ancient Gold Placer Mines Co. produced a small amount of gold bullion which had a fineness of 0.881 in gold and 0.117 in silver. This gold dust was recovered from the gravel in doing assessment work on the claims.

Pine Nut district.—Several small lots of gold ore were treated by amalgamation at the Adams & Taylor custom mill, 20 miles northeast of Wellington, and also at Fulstone's mill, near Wellington. The ore treated in these mills came from the Lough Burrough mine, which was operated intermittently during 1923. The property is opened by three tunnel levels, representing 5,000 feet of work, and a vertical shaft 50 feet deep.

Red Canyon district.—The Defiance Mines Co. produced one small lot of lead ore containing silver.

Silver Glance district.—The Orphan group, which includes the Ventura claim, was developed by the Carson Valley Mining Co. This property is about half a mile southeast of Mountain House and has a five-stamp mill equipped for amalgamation and concentration. A little gold bullion was recovered in testing ore from the Ventura claim.

ELKO COUNTY

In Elko County copper and lead showed increases in 1923, but there were five less producers than in 1922, and all the other metals decreased. The ore mined decreased from 48,850 to 43,512 tons, gold from $540,192 to $348,752, silver from 134,682 to 100,513 fine ounces, and total value from $721,383 to $516,609. Copper increased from 31,163 to 40,976 pounds, and lead from 769,127 to 1,134,465 pounds.

Contact district.—Lessees operating the Delano property shipped two lots of oxidized copper ore containing silver.

Delno district.—The Panther Mines Co., operating the Delno mine, did considerable development work and produced oxidized lead ore containing silver, a little copper, and some gold.

Gold Circle district (Midas).—Five mines in the Gold Circle district produced 165 tons of ore, from which was recovered $2,179 in gold and 85 ounces of silver. All the ore was treated in local mills by the amalgamation process. The principal producers were the Esmeralda, Gold Circle, and Gold Circle Queen properties. Development of the Missing Link vein was started by the Red Hills Florence Mining Co., and a shaft was said to be 500 feet deep in October.

Island Mountain district.—The Gold Center property produced a small lot of gold ore, which was shipped to the smelter. A test lot of the ore was treated in the Huntington mill on the property, and a little gold bullion was recovered.

Jarbidge district.—The output of three mines in the Jarbidge district amounted to 40,629 tons of ore, from which was recovered bullion containing $341,400 in gold and 37,959 ounces of silver, valued together at $372,526. The principal producer was the Elkoro Mines Co., a subsidiary of the Yukon Gold Co., which operated its mine and plant continuously, except for short interruptions due to power trouble. The ore body is a replacement deposit in a fault fissure in rhyolite. The mine is opened by an adit 2,600 feet long and has a cyanidation plant with a daily capacity of 100 tons. From the published report of the Yukon Gold Co. for 1923 the following paragraphs are taken:

> Mining operations were conducted in the Long Hike, Starlight, and O. K. mines of the Elkoro Mines Co., also in the property of the subsidiary Jarbidge Gold Mining Co. and several leased mines. A total of 40,244 tons was milled, which yielded $366,517. The average value of the ore milled was $9.11. The total cost of mining and milling, excluding depreciation and development, was $227,106, or $5.64 a ton. $25,452 was charged off in connection with current development in the properties of the Elkoro Mines Co., leaving a net profit of $113,959. There was expended in development work on leased properties the sum of $69,487. * * *
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> The Long Hike vein, which has been the most productive of any on the company's property, was followed through 500 feet of irregular fissuring and faulting into solid ground where an ore body was encountered. This has been driven on for over 600 feet, with an average value of $15 per ton for a width of 6 feet, and its upward continuation has been proven for 175 feet. This work has added over 50,000 tons to the developed ore.

One small lot of gold bullion was produced from the Sunday property. Construction of the 80-ton cyanide mill of the Bluster Consolidated was well under way in July, to be finished in December.

Lone Mountain district.—From the Rip Van Winkle mine a small lot of lead ore containing silver was shipped to the smelter.

Mud Springs district.—The Monitor claim, 30 miles west of Currie, on the Nevada Northern Railroad, produced 25 tons of silver-lead ore, which was shipped to the smelter.

Railroad district.—Six producers in the Railroad district reported the output of 123 tons of ore of shipping grade, which contained $3,083 in gold, 2,093 ounces of silver, 5,411 pounds of copper, and 21,593 pounds of lead, valued in all at $7,106. Most of the ore was produced from mine dumps in the district, and some of it was mined from the Gray Eagle property.

Ruby Mountain Range district.—Lead ore was shipped from the American Beauty and L. C. mines. At the American Beauty property preparations were under way in December for active developments early in 1924. The mine is opened by an adit 185 feet long and has 200 feet of drifts. The ore produced in 1923 was sulphide and contained gold, silver, lead, and zinc. A newly completed auto road to the mine cost $18,000. Before the completion of this road the ore was packed 6 miles on mules. The L. C. mine has been opened by approximately 1,000 feet of tunnels and drifts.

Spruce Mountain district.—The output of 1,221 tons of ore of shipping grade by four producers in the Spruce Mountain district contained $166 in gold, 25,753 ounces of silver, 5,993 pounds of copper, and 522,143 pounds of lead, valued in all at $58,714. Most of this output was oxidized ore, which was hauled by autotruck from the Spruce Monarch mine 27 miles north to Tobar, on the Western Pacific Railroad. One test lot of lead ore containing silver was shipped from the Adah H. and Ohio No. 1 properties.

Tecoma district.—The Jackson property produced several small lots of lead ore containing silver. The property is opened by shafts and tunnels, and 300 feet of development work was done in 1923.

ESMERALDA COUNTY

The production in Esmeralda County showed decreases in all items except copper and lead. The ore decreased from 28,562 to 22,074 tons, gold from $338,294 to $170,966, silver from 626,498 to 458,530 fine ounces, and total value from $967,416 to $551,025. Copper increased from 2,248 to 2,626 pounds, and lead from 42,201 to 52,540 pounds. There was one less producer than in 1922.

Desert district.—Silver ore was shipped to a milling plant at Tonopah from the Black Mammoth property, which is opened by an inclined shaft and a tunnel.

Dolly district.—From the Spiritual claim, 12 miles south of Tonopah, near Lone Mountain, silver ore of good grade was shipped to the smelter.

Goldfield district.—In 1923 the output of ore in the Goldfield district averaged $38.67 a ton, against $48.06 in 1922. Of the ore produced, 2,292 tons was of milling grade and 845 tons was shipped to the smelter. The bullion recovered from milling ore contained 3,974.36 ounces of gold and 2,983 ounces of silver, and the crude smelting ore contained 496.33 ounces of gold, 630 ounces of silver, 2,263 pounds of copper, and 5,950 pounds of lead. The copper output showed a small increase, and no lead had been produced in 1922, but gold and silver decreased considerably. The total value of the output of the district was $96,456, compared with $270,065 in 1922. Most of the ore came from the Goldfield Consolidated mine and was shipped to the Tonopah cyanidation mills, and smaller lots of siliceous ore were shipped to the smelter at Kennett, Calif., and to a smelter near Salt Lake City, Utah. The ore was mined by lessees under an arrangement with the company which divided the mine into small blocks. A small lot of placer gold with a fineness of 0.990 from surface workings and a clean-up of the milling plant represented but a small part of the total output in 1923. Other producers were the Florence, where three lessees worked, the Diamondfield

Daisy, the Great Bend, and the Jumbo Extension, each of which produced small lots of gold ore. The proposed 2,200-foot shaft of the Goldfield Deep Mines Co. had reached the 1,420-foot point in August.

Gold Mountain (Divide) district.—Continued activity at the Tonopah Divide mine resulted in considerable development work and a large output of ore. The Divide Extension and Hasbrouck mines were also producers. According to the printed report of the Tonopah Divide Mining Co. for 1923, 11,786 tons of ore valued at $402,336 in gold and silver and 4,322 tons of dump ore valued at $51,418 were shipped 6 miles to Tonopah for treatment by cyanidation. The gold and silver bullion recovered was valued at $409,592. After deducting all expenses, including depreciation, there was a net profit of $173,241. Dividends paid to stockholders in 1923 amounted to $202,960. Development work was continued on the 1,300 and 1,400 foot levels after the decrease in the price of silver no longer made certain ore profitable to ship.

Hornsilver district.—Two small lots of silver ore were produced from the Venus and Silver Dollar properties.

Klondyke district.—The original Klondyke property and the Golden State mine produced silver ore, some of which was shipped to the cyanidation plants at Tonopah and some to the smelter at Kennett, Calif.

Lida district (Tule Canyon).—The Lone Mountain mine, operated by lessees, produced a small lot of lead-silver ore, and similar ore was produced from the Margaret group. In Tule Canyon placer gravel was worked by rockers and produced a little gold dust.

Montezuma district.—From the Harmill Divide property 30 tons of lead ore containing 13 ounces of silver and $2.60 in gold to the ton and 48 per cent of lead was shipped to a smelter near Salt Lake City, Utah.

Silver Peak district.—The Mary mine was worked by lessees, and considerable ore was milled which produced bullion. Part of the ore was shipped to the cyanidation mills at Tonopah. One lot of ore treated by amalgamation was reported mined from the Valcalda property.

Tokop (Gold Mountain) district.—Ore was shipped from the Blue Jay mine to the cyanidation mills at Tonopah. A small lot of lead ore was shipped to the smelter.

Windypah district.—The Ruth group of claims produced lead ore containing silver, and a trial shipment was made by way of Blair Junction to a smelter in Utah. This group of claims probably includes what was once known as the Confidence prospect.[5]

EUREKA COUNTY

Although the number of producers in Eureka County declined from 21 to 17, the production was considerably more than in 1922. Ore increased from 4,441 to 27,074 tons, gold from $40,438 to $87,017, silver from 49,866 to 87,459 fine ounces, copper from 69,681 to 646,870 pounds, lead from 592,430 to 1,398,929 pounds, and total value from $132,295 to $351,748.

[5] Spurr, J. E., Ore deposits of the Silver Peak quadrangle, Nev.: U. S. Geol. Survey Prof. Paper 55, p. 92, 1906.

Eureka district.—Ore of shipping grade produced by 12 mine operators in the Eureka district amounted to 1,229 tons. In addition to the ore, considerable arsenical speiss was shipped. Milling ore amounting to 4,737 tons from one property produced lead concentrate containing silver, and 15 tons of gold-silver ore was shipped to a mill at Tonopah for treatment by cyanidation. The total output of ore and speiss, containing gold, silver, copper, and lead, was valued at $343,803, or $12.76 a ton. Most of the ore was shipped by the Croesus Mining Co. and by lessees on the Excelsior and Diamond property. Other producers of shipping ore were the Cyanide, Eureka Prince, and Hamburg properties. From the Holly property considerable milling ore was produced and treated in the 100-ton concentration mill equipped with tables and flotation cells. Most of the ore was treated in an experimental mill until the mill of larger capacity was completed. The mine is opened by a vertical shaft 700 feet deep and has 10,000 feet of levels and other workings. From the slag dump of the old Richmond-Eureka smelter[6] 21,094 tons of speiss was shipped, nearly half of which went to the smelter at Midvale, Utah. The Ruby Hill mines were under development, and the Locan shaft was sunk to the 1,200-foot level. A small quantity of ore was mined.

Lynn district.—Several small lots of bullion having a fineness of 0.925 in gold were recovered from placer property in the Lynn district and either sent directly to the mint or sold to local dealers. The largest output of gold came from the Bulldog placer. The Lynn Big Six mine was under development.

Mineral Hill district.—Three producers in the Mineral Hill district reported the output of 137 tons of ore, containing principally silver and lead with a little copper, valued at $6,694. Most of the lead ore came from the Union mine, operated by lessees. Other producers were the Homestake and Hard Pan claims.

HUMBOLDT COUNTY

Black Rock district.—From the Silver Camel claim a small lot of silver ore was shipped to the smelter.

Gold Run district.—Six producers in the Gold Run district reported 84 tons of ore, containing principally silver and lead, valued at $3,081. The Dolomite, Great Republic, and Moore mines produced most of the output of the district.

Iron Point district.—The Silver Coin property produced an increased quantity of silver ore, containing lead and copper. The ore was shipped to several smelters and averaged nearly 60 ounces of silver to the ton. The property has been opened to a depth of 200 feet by the owner and lessees.

National district.—Considerable activity in the way of development resulted in an increased production from the National district in 1923. The output of ore, bullion, and some concentrate, part of which came from a locality 28 miles north of Winnemucca, contained $11,855 in gold, 9,654 ounces of silver, and small quantities of copper and lead, having a total value of $19,806, or $181.71 a ton. The Buckskin property, at National, operated by the Califor-

[6] United States Smelting, Refining & Mining Co. Eighteenth Ann. Rept., for year ending Dec. 31, 1923.

nia National Gold Mining Co., was the principal producer and shipped gold-silver concentrate in December. Lessees on the property of the National Mines Co. and the Charleston Hill mine produced gold and silver bullion, as well as some shipping ore.

Red Butte district.—From the Prodigal claim one lot of silver ore containing copper was shipped to a smelter in California.

LANDER COUNTY

Battle Mountain district.—The output of ore and placer bullion by six deep-mine operators and five placer producers in the Battle Mountain district was valued at $96,516. One producer shipped arsenical ore, but the arsenic content was not included in the total. The total ore mined was 5,620 tons, containing $8,070 in gold, 56,368 ounces of silver, 34,344 pounds of copper, and 436,006 pounds of lead, valued in all at $89,861. The Irish Rose mine, operated by the Toulon Arsenic Co., was the largest producer of ore. Other producers of ore were the Copper Canyon, Golden Sceptre, and Bentley properties. The ore from the Copper Canyon property was valuable as a furnace-lining material known as clay stone, high in silica and alumina, to be used at the Mammoth Copper smelter at Kennett, Calif. This ore contained a trace of gold and 0.10 ounce of silver to the ton, 6.14 per cent of copper, 56.6 per cent of silica, 1.2 per cent of iron, and 22 per cent of alumina. Placer bullion with a fineness of 0.880 to 0.907 in gold contained $6,619 in gold and 44 ounces of silver. The Homestake Consolidated placer mine produced most of the output.

Bullion district.—Three producers in the Bullion district shipped 49 tons of smelting ore, containing silver, lead, and gold, valued at $3,859. The Euclid and Phoenix groups of claims produced the largest quantity of lead ore.

Cortez district.—Considerable ore was treated in the new milling plant of the Consolidated Cortez Silver Mines Co. Silver was recovered from the ore by cyanidation, and some concentrate was shipped to the smelter. The mill was treating an average of about 125 tons of ore a day in July. Table concentration of the heavier minerals is said to have eliminated some objectionable element, so that the cyanide consumption was lowered to 4 pounds to the ton of ore crushed.

Hilltop district.—Rich silver ore from the Aztec mine and gold ore from the Hilltop property constituted the total production of the Hilltop district in 1923. The Hilltop mine and mill were closed in September.

Lewis district.—The Betty O'Neal mine and concentration-flotation plant were operated continuously during 1923, but production was considerably reduced on account of a scarcity of miners and timber men. The ore milled was mostly sulphide with a siliceous gangue and amounted to 38,150 tons, from which was recovered concentrate containing silver, lead, and a little copper. The mine is opened by a vertical shaft 330 feet deep and a tunnel 2,700 feet long. In 1923 the company paid dividends amounting to $117,056.10. The Betty O'Neal mine is an old producer of gold and silver, having been opened as a prospect in 1880 and producing shortly after at the rate of $2,000 a month. By the fall of 1882 the rate of pro-

duction was $30,000 a month. The ore was treated in the Star Grove mill, in Lewis Canyon. The mine was closed in October, 1882, on account of a boiler explosion. Water was allowed to fill the shaft, and unwatering of the mine was not successfully attempted until 1920. At the portal of the 2,200-foot adit to the mine a mill equipped for oil flotation was built and put into operation in October, 1922. Three months after the mill started the first dividend to stockholders was declared. A full description of the mill was recently published.[7]

Reese River district.—Silver ore was shipped from the Austin Manhattan property by lessees, who were the only operators reporting production in the Reese River district in 1923.

LINCOLN COUNTY

The production in Lincoln County showed notable gains, though the number of producers decreased from 17 to 10. The ore increased from 38,531 to 93,145 tons, gold from $52,538 to $87,215, silver from 416,109 to 655,776 fine ounces, copper from 317,306 to 348,466 pounds, lead from 3,579,813 to 6,842,459 pounds, zinc (none in 1922) 2,756,118 pounds, and total value from $708,373 to $1,342,563.

Groom district.—The Groom mine produced considerable high-grade lead ore containing silver. This ore is sulphide with a calcareous gangue and is hauled by autotrucks 103 miles to the railroad station at Las Vegas. The property is opened by two shafts 100 feet deep and has been developed by 800 feet of drifts and an adit 1,200 feet long.

Highland district.—The Mendha and Chisholm properties were operated, and shipments of lead ore containing silver were made to the smelters.

Jack Rabbit district.—Considerable shipments of ore were made from the Bristol Silver property.

Patterson district.—From the Lake Valley mine silver bullion was recovered by cyanidation from ore treated in a milling plant on the property.

Pioche district.—Four producers in the Pioche district reported an output of 84,147 tons of ore and tailings, containing $82,005 in gold, 543,115 ounces of silver, 92,257 pounds of copper, 5,393,902 pounds of lead, and 2,756,118 pounds of zinc, valued in all at $1,105,910, or $13.14 a ton. The Louise and Prince Consolidated mines produced the most ore. This ore is valuable principally for its fluxing qualities and contains considerable iron and manganese and some lime, all of which is generally paid for, as well as the gold, silver, lead, and copper. The Combined Metals property was a large producer of lead-zinc ore carrying silver and gold. Most of this ore was shipped in 1913 to Canon City, Colo., for reduction and was said to contain $1 in gold and 10 ounces of silver to the ton, 25 per cent of zinc, and 10 per cent of lead. The Combined Metals (Inc.) and the National Lead Co. own the stock of the Combined Metals Reduction Co., which started in 1923 to reconstruct the old Honorine mill at Bauer, Utah. The new mill will have a capacity of 300 tons and will be equipped with a new flotation-con-

[7] Salt Lake Min. Rev., Oct. 30, 1923.

centration process for the treatment of lead-zinc ores. The mill was completed in June, 1924, to receive the output of the Combined Metals property at Pioche and local custom ore.

The Prince Railroad, owned by the Prince Consolidated Mining Co., operated a daily train part of 1923 hauling Virginia Louise ore and tailing to Pioche for shipment to the smelters.

LYON COUNTY

In Lyon County the production of copper was 33,913 pounds, as compared with none in 1922; all the other items showed decreases—number of producers from 14 to 12, ore from 2,841 to 1,463 tons, gold from $125,217 to $50,325, silver from 7,837 to 5,037 fine ounces, and total value from $133,054 to $59,440.

Mason Pass district.—Ore produced from the May Adams property was treated in a 10-ton amalgamation plant and yielded gold bullion.

Ramsey district.—Gold ore from the Lahontan mine was treated by amalgamation. The ore was mined in the course of assessment work on the property.

Silver City district (*Palmyra*, *Dayton*, *Como*).—From the treatment of 699 tons of ore at amalgamation plants, 300 tons of tailing treated by cyanidation, 2 tons of ore shipped directly to a smelter, and placer bullion from the Gold Canyon dredge, $46,724 in gold and silver was produced. The Buckeye Comstock, American, Overland, and Oest properties produced the ore, which was treated at custom milling plants in the district. All the ore is put through an amalgamation plant, and the tailing from the amalgamated ore is purchased by a neighboring plant and treated by cyanidation. The large dredge was operated by electric power by the Gold Canyon Dredging Co. until April 5, 1923, and has since been dismantled. During the three months of operation in 1923 the dredge treated 252,873 cubic yards of gravel.

Talapoosa district.—Silver ore containing gold was shipped to a cyanidation plant at Tonopah and to smelters from the Talapoosa mine.

Yerington district.—Experimental leaching operations at the Mason Valley property resulted in the shipment of some copper precipitate. These experiments and the survey for an extension of the railroad spur from the Bluestone property to the Mason Valley mine gave evidence of a possible renewal of mine operations. The Mason Valley Mines Co. owns the Mason Valley and Bluestone mines and a smelter at Thompson, 1 mile from Wabuska station, on the Hazen-Mina branch of the Southern Pacific Railroad. The Nevada Copper Belt, a standard-gage railroad owned by the Nevada Douglas Consolidated Copper Co., connects the mines with the smelter. The railroad runs south from Wabuska through Mason Valley, skirting the Singatse Range to the south end and doubling back on the north side to the Ludwig mine of the Nevada Douglas Co. The Bluestone spur runs from the main line at Mason to the mine, twisting and winding around the hills. During the time the smelter was in operation the Nevada Douglas, Mason Valley, and Bluestone mines shipped to the Thompson plant. The Bluestone confined its shipments to the siliceous ores, milling the sulphide ore at its flotation mill and shipping concentrates to smelters in Utah.

The Thompson smelter consists of two blast furnaces with a daily capacity of 1,800 tons, a sintering plant, two stands of 12-foot converters, a sampling mill for custom ores, and extensive storage bins. It is the plan of the management to install reverberatory furnaces, but if the smelter is put into operation soon it would appear that the blast furnaces will be used and concentrates sintered. The Mason Valley Mines Co. has applied to the Interstate Commerce Commission for a differential rate from the copper mines of Plumas County, Calif., as between Wabuska and Utah smelters. The case has been heard and briefs filed, but no decision has been made. The Plumas County flotation mills turn out a product high in sulphur, which is very desirable as a flux. In 1921 the freight rate was reduced, but the Western Pacific Railroad made a new "open car" rate to Utah smelters equaling the rate to Wabuska. The Mason Valley Mines Co. then applied for a definite differential rate based upon the length of the haul.

MINERAL COUNTY

The production of ore in Mineral County increased from 33,278 to 139,929 tons, gold from $20,342 to $60,579, silver from 193,919 to 635,350 fine ounces, copper from 5,063 to 17,942 pounds, lead from 2,056,098 to 3,124,176 pounds, zinc from 1,224,000 to 2,320,053 pounds, and total value from $397,798 to $960,658. These gains were made by 36 producers, or 3 less than in 1922.

Bell district (Mina, Omco).—The Simon silver-lead mine was the principal producer in the Bell district. Considerable ore was treated in the concentration mill on the property, and zinc concentrate was shipped to zinc plants in Texas, Oklahoma, and Montana. Lead concentrate was shipped to Midvale, Utah. One lot of oxidized lead ore was produced from the Chloride mine.

Buena Vista district.—Ore previously mined from the R. & S. silver property was shipped to the smelter in 1923.

Columbus district.—Owing to the low price of silver, the Candelaria Mines Co. closed its mine and mill after 11 months' operation. The mine is opened by a vertical shaft 800 feet deep and has a number of adits. The mine is an old one and was extensively opened by early operators. The geology of the Columbus district, or that part in which the Candelaria mines are situated, was recently described by Knopf.[8]

Garfield district.—Operations on the Mabel group by the West End Consolidated Mining Co. resulted in the output of considerable ore containing lead, silver, and gold. Most of this ore was shipped to the cyanidation plant of the company at Tonopah, and that containing lead was shipped to various lead smelters. The Mabel mine[9] produced 659 tons of ore averaging 1.24 ounces of gold, 106.39 ounces of silver, and 99 pounds of lead to the ton. The value of the ore was $77,849.65. The cost of transportation from the mine to Tonopah, including treatment charge, was $37.71 a ton, leaving a net return of $80.42 a ton. The Silversides property produced lead-silver ore of smelting grade.

[8] Knopf, Adolph, The Candelaria silver district, Nev.: U. S. Geol. Survey Bull. 735, pp. 1–22, 1923.

[9] West End Consolidated Mining Co. Seventeenth Ann. Rept., for year ending Dec. 31, 1923.

Hawthorne district.—Five producers in the Hawthorne district reported 99 tons of ore, containing $5,181 in gold, 2,237 ounces of silver, 263 pounds of copper, and 6,557 pounds of lead, valued in all at $7,513. Of the ore produced 79 tons was treated in an amalgamation mill and besides bullion yielded lead concentrate. The producers were the Gold Bug, Lucky Boy, Sunset, Western Girl, and Good Hope properties.

Pinegrove district.—One lot of gold ore containing silver, taken out in developing the Mineral Mountain mine, was shipped to the smelter. The 100-ton cyanidation mill on the property was not operated.

Rand district.—Several lots of gold-silver ore from the Rand mine were sold to the smelter. The mine is opened by a vertical shaft 450 feet deep and has about 3,000 feet of drifts and crosscuts. About 300 feet of development work was done in 1923. The ore is hauled 17 miles to the railroad.

Regent district (*Rawhide*).—Eight deep mine operators in the Regent district reported the output of 399 tons of ore, 162 tons of which was of shipping grade and 237 tons produced gold and silver principally by cyanidation at the Tonopah custom mills. Most of the ore was mined from the property of the Nevada New Mines Co., and good-sized lots came from the Morning Star and Victory claims. The recovery of a small quantity of gold bullion was reported from the operations of surface placers.

Silver Star district (*Marietta, Black Mountain*).—Eight producers in the Silver Star district reported the output of 143 tons of ore, containing $2,004 in gold, 2,849 ounces of silver, 1,219 pounds of copper, and 16,495 pounds of lead, valued in all at $5,673. With the exception of 33 tons of ore shipped to the smelter, the entire output was treated in amalgamation mills and produced gold and silver bullion. The ore of shipping grade was mined from the Endowment, Silver Bar, Venture, Black Hawk, Contact, Congress, and Bird Song claims. Milling ore was produced from the property of the Gold Range Mining Co. and the Gold Scratch claim.

NYE COUNTY

The number of producers in Nye County increased from 78 to 81, but gold was the only item to show a gain in production—from $1,548,170 to $1,642,719. The ore decreased from 496,122 to 415,739 tons, silver from 5,553,563 to 5,232,433 fine ounces, copper from 2,549 to 572 pounds, lead from 139,109 to 18,681 pounds, and total value from $7,109,728 to $5,934,706.

Athens district.—The Warrior Gold Mining Co., operating the Athens mine, produced gold bullion.

Bellehellen district.—Milling ore containing gold and silver from the Clifford property was treated in the custom plants at Tonopah. The 50-ton cyanidation mill of the Bellehellen Merger Mines Co. was reported to be treating gold-silver ore from the Dorothy vein in June but operated only a short time and was then closed.

Bruner section (*Phonolite*).—The Leader group produced a small lot of gold ore containing silver, and gold bullion was recovered from ore mined from the Fly property.

Bullfrog district.—Gold ore containing silver was shipped from the Mayflower and Montgomery-Shoshone properties to the custom mills at Tonopah for treatment.

Fairplay district.—The Crystal gold claim, 3 miles west of Goldyke, was operated and produced a little gold bullion.

Goldyke district.—One lot of ore from the Butler group was shipped to a custom mill at Tonopah.

Hannapah district.—The Silver Chloride and Silver Leaf claims produced milling ore containing principally silver. The ore was treated at a custom mill at Tonopah.

Johnnie district.—The milling plant of the Johnnie mine was operated and gold bullion recovered. The mine is opened by an inclined shaft 1,000 feet deep. About 200 feet of development work was done in 1923. The Evolution placer was developed, and placer gold was recovered by dry washing of the surface material.

Mammoth district.—Lead ore was shipped from the Smuggler property to a smelter.

Manhattan district.—Fifteen producers of ore in the Manhattan district reported an output of 23,420 tons, all of which, except one lot shipped from the Manhattan Union property to a custom mill at Tonopah, was treated in the district. The total output of the district, including the bullion from 13 placer operators, was valued at $315,975. The largest producer of ore was the White Caps Mining Co., which produced gold bullion in its 70-ton cyanidation plant and sold arsenical ore (realgar and orpiment) to arsenic plants at Midvale, Utah, and Martinez, Calif. Several mines in the district took advantage of the treatment of ore in the War Eagle amalgamation mill. The placer output was $10,810 in gold and 236 ounces of silver. The placers furnishing most of the gold were the Bulldog, Arizona, China, Hoodlum, Little Grey, and Top Knob No. 2 properties. A geologic report [10] giving the history and production and the geology of the ore deposits in the Manhattan district was recently issued.

Millett district.—Concentrate containing principally gold was shipped from the Portland mine.

Philadelphia district (*Belmont*).—Old tailing from the Monitor Belmont property was treated by cyanidation and yielded silver bullion. The tailing dump has been exhausted and the milling plant dismantled, according to the report of a lessee.

Reveille district (*Arrowhead*).—Three producers of ore in the Reveille district reported the output of 242 tons, all of which, with the exception of 1 ton of lead ore shipped to the smelter, was of milling grade and produced silver bullion by cyanidation at the Tonopah custom mills. The principal production was made by a lessee operating the property of the Southwestern Nevada Mines Co.

Round Mountain district.—Gold and silver ore amounting to 12,773 tons was mined by seven operators in the Round Mountain district. All the ore, except 11 tons that was of smelting grade, was treated in the amalgamation mills of the Fairview and Round Mountain companies. Placer gold was recovered from the hillside of the Round Mountain property. It is reported that Thomas

[10] Ferguson, H. G., Geology and ore deposits of the Manhattan district, Nev.: U. S. Geol. Survey Bull. 723, 1924.

"Dry Wash" Wilson, who was one of the first to work the placer deposits of Round Mountain and Manhattan profitably, has found a new gravel channel about a mile southwest of the hill called Round Mountain, which carries high-grade gravel. The pay gravel was struck in a vertical shaft at a depth of 223 feet, and the shaft has been for the last 15 feet in gravel that will run from $4 to $5 a yard. The channel should enter the property of the Round Mountain Co. and if it continues as rich as is indicated by the present meager developments will add materially to the gold output of the district.

San Antone district (*Royston*).—The Canadian Leasing Co., operating the Golden Eagle claim, mined silver ore and lead ore, which was shipped to a cyanidation mill at Tonopah and to smelters in California.

Silverton district.—Silver ore from the Treasure Hill property was shipped to a mill at Tonopah for treatment.

Tolicha district.—The Landmark claim, opened by an inclined shaft 150 feet deep, produced gold ore containing a little silver, which was shipped as test lots to a smelter in California and to Tonopah for treatment. The Tolicha district is 44 miles southeast of Goldfield and only recently attracted the attention of prospectors.

Tonopah district.—All the ore produced in the Tonopah district in 1923 was siliceous ore of milling grade, containing principally silver. The output decreased during the final period of operation of the Pittman Act—ore from 472,865 to 371,946 tons, gold from $1,179,302 to $1,107,329, silver from 5,436,080 to 5,176,306 fine ounces, and total value from $6,615,382 to $5,351,900. The number of producers remained the same as in 1922. The total output of the district from 1904 to 1923 has been as follows: Ore, 7,153,783 tons; gold, $31,374,992; silver, 143,517,550 fine ounces; copper, 12,113 pounds; lead, 214,523 pounds; total value, $128,217,347.

From the Tonopah Extension property [11] 144,917 tons of ore was mined and milled, which contained 2,227,418.68 ounces of silver and 23,211.18 ounces of gold. The total value of the ore was $2,048,394. The tailing contained $1.085 a ton, or a total loss of $157,193. The recovery was 2,053,442.92 ounces of silver and 21,533.65 ounces of gold, valued together at $1,891.201. The cost of mining, including all development work, was $5.737 a ton, milling $3.457, and marketing, including refining, express, and freight, $0.252—a total cost of $9.446. With the metal loss in tailing of $1.085 and the cost of depreciation, etc., amounting to $0.555 a ton, the total cost was $11.086 a ton. The net amount realized per ton of ore was $3.079. Dividend distributions during the company's fiscal year amounted to $278,543.21, making a total of $3,644,427 since July 1, 1905. Recoveries by value of the metals from the ore averaged 92.19 per cent of the silver and 92.77 per cent of the gold, an increase of 1.34 per cent over those of the previous year. The consumption of cyanide, equivalent to 100 per cent sodium cyanide, was 0.1195 pound per ounce of bullion recovered. The consumption of zinc per ounce of bullion recovered was 0.0575 pound, and the average fineness of the bullion produced was 0.946 in silver and 0.009 in gold. If gold is regarded as a

[11] Tonopah Extension Mining Co. Nineteenth Ann. Rept., for year ending Mar. 31, 1924.

by-product and net costs are credited with the value of the gold recovered, the cost of producing an ounce of silver was 48.90 cents. In operating from the Victor shaft a new vein known as the 1814 vein was found in the footwall of the Murray vein, and drifts were run on it for 400 feet. About 200 feet of the drifting was in a vein of good ore averaging about 6 feet in width. Stoping from this level produced about 50,000 tons of ore, and work on the 1940 intermediate level produced 55,000 tons of ore of good grade. The Murray and Anchor veins were intersected on the 2,000-foot level, where stoping and development produced 35,000 tons of good ore. From this level a three-compartment raise connects with the Cash Boy shaft at the 1,760-foot level. This shaft will be continued to the 2,250-foot level and makes five operating shafts on the property. Pumping facilities provide for taking care of 750 gallons of water a minute at the Victor shaft and 1,200 gallons a minute at the McKane shaft.

The total ore produced from the Belmont mine amounted to 45,123 dry tons, which was of slightly higher grade but less by 42,654 tons than the output of 1922. A total of 45,708 tons, including 584 tons from ore stock, was milled and contained 8,393.52 ounces of gold and 844.549 ounces of silver, valued together at $850,354, and averaged 0.18 ounce of gold and 18.48 ounces of silver to the ton, or a total value of $18.60. Operating costs were higher than those of previous years. Mining costs increased 18.10 per cent and milling costs 21.17 per cent. The increased mining costs were due chiefly to the decreased ore output. The lower price of silver in the last half of 1923 greatly affected the operations of this company, according to its annual report for 1923, which says:

> The unexpectedly early completion of silver purchases at $1 per ounce under the Pittman Act in June necessitated the selling of silver bullion at regular current market quotations, which were remarkably steady during the remainder of the year at about 64 cents per ounce. At this price it requires an ore of higher silver content to make a profit, and it became imperative to sort the ore, thus reducing the tonnage to about 100 tons a day. The same conditions affected the mines from which your Belmont mill was receiving custom ore, many of them being obliged to close down entirely. With no assured custom ore in sight it was uneconomical to operate your Belmont mill (which has a daily capacity of 500 tons) upon such a small tonnage, and the mill was closed down on August 1. The Belmont mine ore since then has been shipped to the mill of the Tonopah Mining Co. of Nevada at Millers, which was more easily adaptable to handle a reduced tonnage.
>
> To meet the enforced reduction in earnings your management immediately inaugurated sweeping reductions in expenses. This involved the cutting down of the office forces in Philadelphia and Tonopah to the lowest possible minimum, reduction in salaries from the president down, and the scaling down of mine forces, both top men and underground men. * * *
>
> On December 18 a new vein was encountered on the 1,000-foot level of the Belmont mine in virgin ground. This vein has been named the I. O. U. vein, which is the name of the claim in which it was struck. The vein has been drifted on for a distance of 269 feet on the 1,000-foot level, it has been cut on the 900-foot level, at which point it is 2½ feet in width and assays over $30. Crosscuts have been started to pick up the vein on the 700, 800, 1,100, and 1,200 foot levels.

The mine and mill of the Tonopah Mining Co. operated without interruption during 1923. Prior to the expiration of the Pittman Act in June all ore in sight was mined and milled. As the ore reserves were thus greatly depleted, operation was continued on a reduced scale, which, according to the annual printed report of the

company for 1923, gave a satisfactory profit. Dividends to stockholders from the beginning of operations amount to $15,475,000, of which $150,000 was paid in 1923.

From the West End property[12] 70,458 dry tons of ore was milled, containing 12,339.80 ounces of gold and 1,128,135 ounces of silver, which had a gross value of $1,212,011.29. Of this ore 55,446 tons came from the Ohio vein and its branches; 12,292 tons, averaging $13.67 a ton, came from the West End vein; and 197 tons, valued at $12.72 a ton, came from a lease on the Jim Butler property. The average mining cost for the year was $4.80 a ton. Milling of the ore cost $2.95 a ton; mine development cost was $1.06 a ton; and tailing losses amounted to $1.37 a ton, which, with the cost of marketing bullion and transporting ore, made a total of $10.64 a ton and left a total operating profit of $6.56 a ton. The ore milled from the West End, Jim Butler, and Halifax, including some custom ore, yielded 13,699.53 ounces of gold and 1,274,932 ounces of silver. In addition to the ore treated at the West End mill, 4,124 tons was shipped during the period of high price of silver to other custom mills in the district for treatment. These custom mills paid for 90 per cent of the metal content. The cost of milling, including transportation of the ore, was $4.62 a ton.

The Tonopah Midway mine[13] produced ore containing gold and silver valued at $11,150. Nearly all the ore was mined from the South or Merger vein on the 1,200-foot level. This and the 1,330-foot level were the most promising places where ore was developed in 1923.

At the Halifax mine[14] development work amounting to 3,299 feet was done, in the course of which 8,598 dry tons of ore was shipped to the West End mill for treatment by cyanidation. The gold content of the ore was 1,687.38 ounces, and the silver 208,388 ounces, valued together at $222,279. The loss in milling was $18,384, hauling and milling charges were $49,374, lessees were paid $646, and mining costs were $108,224, leaving a net profit of $45,676.76.

Union district.—Sweepings from the old stamp mill on the Blue Bell property yielded a small quantity of gold.

ORMSBY COUNTY

Carson River district.—A little Bullion was recovered from tailing on the old Brunswick mill site by a lessee.

Voltaire district.—A small lot of silver ore, carrying 75 ounces of silver and $1.60 in gold to the ton and 19 per cent of zinc, was shipped from the Crystal claim. The property is about 5 miles southwest of Carson City. The Ohio claim produced a small lot of siliceous silver ore carrying an average of 36 ounces of silver and $2.20 in gold to the ton. The property is opened by an inclined shaft 87 feet deep.

PERSHING COUNTY

Arabia district (*Oreana*).—Lessees operating on the Montezuma, Electric, Jersey, and Last Chance properties produced 110 tons of

[12] West End Consolidated Mining Co. Seventeenth Ann. Rept., for 1923.
[13] Tonopah Midway Mining Co. Ann. Rept. for 1923.
[14] West End Consolidated Mining Co. Seventeenth Ann. Rept., for 1923.

ore, containing $283 in gold, 3,198 ounces of silver, and 35,887 pounds of lead, valued in all at $5,425. This ore was of shipping grade and was sold to smelters. The mines are about 5 miles northwest of Oreana, the shipping station on the Southern Pacific Railroad.

Jersey Valley district.—The Rex claims were developed, and a small lot of silver ore was sold.

Kennedy district.—From the Fourth of July claim silver ore was produced and shipped to the smelter. Lower-grade ore, said to amount to about 100 tons, taken out of the property, was held for future treatment.

Rochester district.—Ten mine operators in the Rochester district reported the output of 91,374 tons of ore and mill-pond sweepings. The content of this output, including a little gold recovered from surface placer mining, was $124,514 in gold and 664,716 ounces of silver, valued together at $669,582. The ore and sweepings had an average value of $7.33 a ton. Placer bullion having a fineness of 0.849 in gold and 0.149 in silver was recovered by sluicing surface dirt from the Bonanza property. Most of the ore output of the district was produced from the property of the Rochester Silver Corporation, which leased its mine and 160-ton cyanidation plant to its former employees, beginning July 7. During 1923 the corporation paid $35,166 in dividends to the stockholders. The Lincoln Hill mine of the Great Western Mines Co. produced gold bullion containing silver, which was recovered in the 2-stamp amalgamation mill on the property. It is reported that reserves of ore amounted to about 5,000 tons, valued at $50 a ton, principally in gold. The Nevada Packard mine and mill were closed in November after treating considerable ore that yielded silver bullion. The company is said to have liquidated its indebtedness and is to be reorganized. A small lot of silver ore was produced from the Buck & Charley mine. Other producers were the Octopus and Abe Lincoln properties.

Rosebud district.—Small lots of ore containing principally silver were shipped to the smelter from the Grubstake and Cora claims.

Seven Troughs district,—A number of lessees reported small lots of gold bullion recovered from ore mined in the Seven Troughs district and treated at local mills equipped for amalgamation and concentration.

Sierra district (*Dun Glen, Central, Sunshine*).—A lessee operating the Black Hill & Mayflower property, at Dun Glen, shipped a small lot of gold ore. From the Essex mine, 6 miles east of Mill City, a small lot of silver ore, averaging 58 ounces of silver and 60 cents in gold to the ton, was produced.

Unionville district (*Buena Vista*).—Five producers in the Unionville district reported the output of 8,089 tons of ore, nearly all of which was milled and produced bullion and a few tons of concentrate containing silver. Only 48 tons of ore, which contained lead, was shipped to smelters. Shipments of crude ore, concentrate, and silver bullion were made from the Arizona Silver property, which is equipped with a 100-ton plant for treating ore by cyanidation and concentration. A lessee milled ore from the Rye Patch property and shipped silver bullion recovered by cyanidation. Other producers in the district were the Buena Vista and Manoa properties.

STOREY COUNTY

The output of Storey County, all from the Comstock district, showed notable increases—ore from 138,752 to 584,237 tons, gold from $298,409 to $956,818, silver from 329,644 to 1,357,559 fine ounces, copper (none in 1922) 912 pounds, and total value from $628,053 to $2,070,150. The number of producers increased from 15 to 21.

Most of the ore was milled, but the total includes 440 tons of old tailings re-treated and 267 tons of silver ore containing a little gold shipped directly to the smelter. One plant in the district produced 93 tons of concentrate containing principally silver and gold with a little copper.

The United Comstock mine was operated throughout 1923, and the mill was still in the experimental stage. The property was credited with the largest output of gold made by a single producer in Nevada, and its output of silver was also large. Operating losses amounted to $239,392 up to the month of September, according to a statement[15] made to the Nevada tax commissioner. The company started its 2,500-ton cyanide mill September 23, 1922, and a year later was treating about 2,000 tons of ore daily and had a monthly pay roll of approximately $90,000. An official report to the Nevada Board of Equalization states that the mine contains 2,000,000 tons of ore valued at $3.10 a ton in gold and silver, with silver at 62 cents an ounce. The ore assays 30 to 35 ounces of silver to 1 ounce of gold. The mill, including its equipment, and all necessary office buildings cost $1,917,403, according to an interesting detailed statement published in a recent journal.[16] Another article[17] written by George J. Young gives a description of the United Comstock's underground operations from which the following paragraph is taken:

> According to Becker, the Gold Hill group of mines produced $86,228,508 from 1859 to 1880. The ores mined totaled 2,455,042 tons, of an average value at the time of $31.05. The present value of an ore of the average grade indicated would be approximately $22.64. The grade of the ore mined by the United Comstock is said to range between $4 and $5 at present prices of silver ($1 an ounce). Thus the present-day miner is handling ores of one-sixth the value of those handled by the historic miner. The crumbs in the nest of the older miner are all that is left. Modern methods and larger-scale operations have made possible a reduction of the operating costs at Gold Hill to a figure sufficiently low to yield an operating profit. As far as Comstock conditions are concerned, a record in low-cost production has been achieved.

On November 1 the Hale & Norcross, Chollar, and Potosi mines and the 75-ton mill of the Comstock Leasing Co. were taken under the control of the Comstock Merger Mines Co. Considerable gold and silver ore was milled from the Chollar, Potosi, Consolidated Virginia, and Ophir mines. The Berry and Lady Bryan mines, in the Flowery district, were operated by the Nevada Canyon Corporation, and the output of gold and silver is included with that of the Comstock district. A little ore was produced from the Mexican mine, and some concentrate was recovered from Union Consolidated ore. The ore from the Justice mine was treated at Silver City, where gold and silver bullion and some concentrate were recovered. Other producers of bullion were the Silver Hill, Santa Catalina, and Ar-

[15] Eng. and Min. Jour.-Press, Sept. 15, 1923, p. 470.
[16] Idem, Jan. 12, 1924, p. 51.
[17] Idem, June 7, 1924, pp. 916–921.

rowhead properties. A little bullion and some rich silver ore from the Phoenix mine were sold to a smelter in California. The tailing dump of the Butters mill, in Sixmile Canyon, east of Virginia City, has at various times attracted the attention of metallurgists, whose samplings are said to have shown on assay 4 ounces of silver and $2 in gold to the ton. Only about 30,000 tons of the original 200,000 tons is left of the tailing dump, and treatment by flotation concentration was tried in a plant constructed in 1922. According to a recent statement,[18] the process was a success, and considerable tailing was treated in 1923. The milling plant has a capacity of 6 tons of tailing an hour, with a flow sheet as follows: The tailing in lumps is dumped into a log washer, the overflow of which goes to a centrifugal pump, by which it is pumped into a 4 by 20 foot tube mill used primarily for disintegrating the tailing. The discharge of the mill goes directly to the first of a series of six Allen type pneumatic cells, making a rough concentrate. This concentrate is recleaned and fed to a Dorr thickener, from which it goes to a small Oliver filter. The tailing from the recleaning cell is fed into the original rougher cells. The reagents in use are basic coal-tar products, which make an extraction of about 80 per cent. A concentrate containing about 200 ounces of silver and 1 ounce of gold was made. The average concentrate contains about 60 to 85 pounds of quicksilver to the ton.

WASHOE COUNTY

Leadville district.—The principal producer in the Leadville district was the Leadville Mines Co., which operated its mill for eight and one-half months and produced concentrate containing lead, silver, and a little copper. The mill treated an average of about 60 tons a day. Most of the ore was mined from the 400 and 500 foot levels and is said to average 20 ounces of silver to the ton and 6 per cent of lead and made a concentrate containing 180 ounces of silver to the ton and 35 per cent of lead. Some tailing from the Tohoqua mill dump was concentrated and the product shipped to a smelter.

Peavine district.—Silver ore carrying gold from the Gold Bond mine and copper ore containing gold and silver from the Silver King claim were sold to the smelter.

Pyramid district.—Ore of smelting grade containing lead and silver was produced from the property of the Sand Consolidated Mines Co.

Washoe district.—The Ford and Galena Hill claims produced one lot of lead ore containing silver, which was shipped to the smelter.

Wedekind district.—Several lots of silver ore containing lead were shipped to smelters from the property of the Wedekind Mines Co.

West Comstock district.—The Bargo mine produced a small lot of gold ore in the course of development work. The stamp mill on the property was not operated.

White Horse district.—Five operators in the White Horse district reported the output of 123 tons of ore, containing $1,894 in gold and 39 ounces of silver, valued together at $1,926. Most of the ore was treated by amalgamation and produced small amounts of bullion.

[18] Nevada Min. Press, Oct. 5, 1923.

WHITE PINE COUNTY

All the metals except zinc showed increases in White Pine County in 1923. The ore increased from 633,505 to 2,844,704 tons, gold from $104,588 to $614,311, silver from 87,434 to 141,363 fine ounces, copper from 22,633,276 to 65,938,720 pounds, lead from 736,737 to 2,420,800 pounds, and total value from $3,315,661 to $10,615,454. Zinc decreased from 484,666 to 334,952 pounds, and the number of producers from 30 to 27.

Aurum district.—About a carload of lead-silver ore was shipped from the Ruby Hill Apex property.

Cherry Creek (Egan Canyon) district.—Silver ore was shipped from four properties in the Cherry Creek district. The principal production came from the Exchequer mine, and smaller lots from the R. S. F., Nevada Northern, and North Mountain properties.

Duck Creek district.—The Ely Amalgamated property was the principal producer in the Duck Creek district and shipped to the smelter 306 tons of sulphide lead ore containing a little silver. The McGill mine produced a small lot of lead ore, which averaged about 41 per cent of lead.

Eagle district (Regan).—Lessees operated the Dandy mine of the Red Hill group, 16 miles southeast of Tippett. Several lots of ore were hauled to Gold Hill, Utah, a distance of 56 miles, and shipped on the Western Pacific Railroad to the smelter. The ore averaged about 30 per cent of lead and 36 ounces of silver and $2.20 in gold to the ton.

Granite district (Steptoe).—Lead ore was shipped from the Cuba and Lewis claims. The Cuba mine is operated through a 700-foot adit.

Hunter district.—A small lot of lead ore was shipped by lessees from the Vulcan property.

Kolchek Creek district.—The Kolchek mine, 3 miles northwest of Cleveland Creek, produced a small lot of ore which was treated in a 4-ton amalgamation and concentration mill erected on the property. The mill was dismantled at the end of operations. About 75 tons of ore was treated, and 1 ton of concentrate, containing 2 ounces of gold and 55 ounces of silver, was sold. A little gold and silver bullion was caught on amalgamation plates.

Osceola district.—Placer mining on property operated by Tilford Brothers resulted in the production of bullion having a fineness of 0.850 in gold and 0.145 in silver.

Robinson district (Ely).—The output of all metals except lead and zinc produced in the Robinson district increased in 1923—gold from $92,825 to $610,892, silver from 27,477 to 82,675 fine ounces, and copper from 22,614,736 to 65,928,279 pounds. The total value increased from $3.212,828 to $10,401,327. Lead decreased from 216,562 to 120,094 pounds, and zinc from 484,666 to 334,952 pounds. There was one less producer than in 1922. The total output of the district from 1904 to 1923 has been as follows: Ore, 41,451,615 tons; gold, $6,916,936; silver, 1,198,398 fine ounces; copper, 932,404,712 pounds; lead, 3,132,900 pounds; zinc, 5,782,270 pounds; total value, $177,848,877.

Reconstruction was continued on the Nevada Consolidated concentrator,[19] which is to replace the one destroyed by fire in 1922. During the greater part of 1923 the new mill had in operation 19 fine-grinding ball mills with an approximate daily capacity of 9,500 tons. Seven more of the ball mills were expected to be added in 1924, thus giving a total capacity of 13,000 tons a day. The ore milled amounted to 2,576,388 dry tons, averaging 1.31 per cent of copper, of which 82.9 per cent was recovered. The concentrate, averaging 10.02 per cent of copper, and crude ore from the mine, averaging about 7 per cent, together with custom ores, were smelted in the company's smelter at McGill. The bullion produced contained 61,573,246 pounds of fine copper, 27,889.81 ounces of gold, and 71,831 ounces of silver, valued in all at $9,445,306. Steam-shovel mining costs of concentrating ores, exclusive of depreciation and Federal, State, and local taxes but including all other overhead expense, were 20.16 cents a ton of ore and 49.78 cents a cubic yard of capping. These costs do not include 40 cents a ton of ore mined, which is charged regularly to cover stripping expense. The cost of underground mining in the Ruth mine averaged $1.0977 a ton. Milling of the ore cost 61.7 cents a ton. Including depreciation of plant and equipment, all taxes, and general and other overhead expenses, the total operating cost was 10.92 cents a pound of copper produced, after applying credits for gold and silver and miscellaneous earnings, as compared with a cost of 12.4 cents a pound similarly calculated for the nine months' operating period in 1922.

The Boston-Ely mine produced several thousand tons of first-class copper ore which was directly smelted at the Steptoe smelter. Lead ore of smelting grade was produced from the Millard mine, which is opened by a 200-foot tunnel and has about 200 feet of drifts. Shipments of oxidized lead ore, zinc ore, and copper ore continued from the property of the Consolidated Coppermines Co. Most of the shipments were lead ore and zinc ore by lessees, and considerable copper ore was milled on company account at the Nevada Consolidated concentrator.

The Consolidated Coppermines Co. and the properties of the Giroux Consolidated Mining Co. and the Butte & Ely Copper Co. were conveyed in September, 1922, to the Consolidated Coppermines Corporation.[20] The first shipment of ore to the smelter after the new corporation took title was made in March, 1923. The Richard mine produced 8,858 tons of ore, which contained 564,615 pounds of copper, 41.38 ounces of gold, and 259.86 ounces of silver. From the Minnesota mine 12,956 tons of ore contained 733,833 pounds of copper, 172.60 ounces of gold, and 599.93 ounces of silver. The Ora mine produced 56,933 tons of ore, containing 1,455,120 pounds of copper, 910.19 ounces of gold, and 2,376.76 ounces of silver. Lessees mined 792 tons of zinc and lead ore, containing 418,600 pounds of zinc, 94,501 pounds of lead, 29.89 ounces of gold, 4,140.80 ounces of silver, and 4,105 pounds of copper. Considerable churn and diamond drilling has shown a large reserve of porphyry ore and high-grade sulphide ore in the property.

[19] Nevada Consolidated Copper Co. Seventeenth Ann. Rept., for 1923.
[20] Consolidated Coppermines Corporation Ann. Rept. for 1923.

Ward district (*Taylor*).—The Ward mine produced a large quantity of oxidized lead ore, containing silver and averaging about 40 per cent of iron, making a product of value to the smelter as a fluxing ore.

White Pine district (*Hamilton*).—Six producers in the White Pine district reported the output of 269 tons of ore, all of which except a small lot of rich ore shipped to Tonopah for treatment by cyanidation was of smelting grade. The total output contained $368 in gold, 8,878 ounces of silver, 6,198 pounds of copper, and 208,455 pounds of lead, valued in all at $23,151. Most of the ore was mined from the Nevada property, and smaller shipments were made from the Rocco Homestake, Great Valley, Jennie A., and Carlisle.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN ARIZONA

(MINE REPORT)

By V. C. Heikes[1]

PRODUCTION

In 1923 the value of the mine production of gold, silver, copper, lead, and zinc in Arizona was $104,301,200, an increase of 66 per cent over that of 1922. Dividends were paid to stockholders by the New Cornelia, Miami Copper, Calumet & Arizona, United Verde Extension, United Verde, United Eastern, Inspiration, Iron Cap, Arizona Commercial, and Midland mining companies, amounting to $14,683,602. The Phelps Dodge Corporation, operating mines at Bisbee and Morenci and also in Mexico and New Mexico, paid $2,000,000, which is not included in the total given above.

The output of all metals produced in Arizona increased considerably in both quantity and value. The average value of the ore increased from $5.85 in 1922 to $6.13 in 1923, but the value in gold and silver decreased from 75 cents a ton to 71 cents.

Mine production of gold, silver, copper, lead, and zinc in Arizona in 1923

	Number of producers	Ore	Gold [a]	Silver [a]	Copper	Lead	Recoverable zinc	Total value
		Short tons		*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
1923	341	17,015,178	$6,121,121	7,343,742	618,928,602	16,291,548	519,103	$104,301,200
Increase from 1922	23	6,269,133	2,596,987	2,811,878	218,885,474	1,220,654	308,479	41,398,475

[a] Includes placer production.

ORE

Copper ore was mined in greatest quantity in Arizona in 1923, followed by gold and silver ore and dry and siliceous gold ore. The total values of the ores were as follows: Dry gold ore, $3,063,953; dry gold and silver ore, $2,228,096; dry silver ore, $956,677; copper ore, $95,715,366; lead ore, $2,259,088; copper-lead ore, $23,234; and lead-zinc ore, $45,873. The placers produced gold and silver valued at $8,913, which makes the State total $104,301,200.

[1] Valuable assistance in the preparation of the report and the compilation of the statistical tables was rendered by B. N. Lowry, of the United States Geological Survey.

Ore and metals produced in Arizona in 1923

Source	Number of producers	Ore		Gold		Silver	
		Short tons	Per cent	Fine ounces	Per cent	Fine ounces	Per cent
Dry gold ore	65	226,585	1.33	142,442.85	48.11	143,796	1.96
Dry gold and silver ore	7	268,537	1.58	35,273.99	11.91	894,653	12.18
Dry silver ore	83	71,171	.42	6,742.02	2.28	930,226	12.67
Copper ore	94	16,331,974	95.98	106,691.21	36.03	4,269,278	58.13
Lead ore	80	115,369	.68	4,514.11	1.52	1,090,534	14.85
Copper-lead ore	11	229		16.74	.01	15,183	.21
Lead-zinc ore	1	1,313	.01				
Total deep mines		17,015,178	100.00	295,680.92	99.86	7,343,670	100.00
Total placers	24			428.31	.14	72	
		17,015,178		296,109.23	100.00	7,343,742	100.00
Increase from 1922		6,269,133		125,629.25		2,811,878	

Source	Copper		Lead		Zinc	
	Pounds	Per cent	Pounds	Per cent	Pounds	Per cent
Dry gold ore	5,179		10,341	0.06		
Dry gold and silver ore	5,206,142	0.84				
Dry silver ore	356,362	.06	30,529	.19		
Copper ore	612,302,029	98.93	7,282	.04		
Lead ore	1,035,034	.17	15,991,220	98.16		
Copper-lead ore	22,856		101,119	.62		
Lead-zinc ore			151,057	.93	519,103	100.00
	618,928,602	100.00	16,291,548	100.00	519,103	100.00
Increase from 1922	218,885,474		1,220,654		308,479	

GOLD ORE

Gold ore, which represented less than 2 per cent of the total output of ore, was mined by 65 producers in 1923, against 72 in 1922. This ore averaged $13 in gold and 0.63 ounce of silver, or $13.52 in all, to the ton. The largest quantity of gold ore was reported by 21 producers in Mohave County, followed by Yavapai County, with 22 producers, and Maricopa County, with 2 producers.

Content of dry gold ore sold or treated in Arizona in 1923

County	Ore	Gold	Silver	Copper	Lead
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Cochise	246	74.27	58	89	
Gila	80	63.26	16		
Greenlee	1	.44			
Maricopa	14,321	687.35	1,504	202	
Mohave	186,870	135,607.45	69,534	284	
Pima	70	62.45	27		
Pinal	165	107.24	190		
Santa Cruz	80	37.00	158		
Yavapai	24,677	5,729.82	72,262	4,604	10,341
Yuma	75	73.57	47		
	226,585	142,442.85	143,796	5,179	10,341

GOLD AND SILVER ORE

Only four counties recorded a production of gold-silver ore, which averaged $2.72 in gold and 3.33 ounces of silver to the ton, with a little copper, and had a value of $8.30 a ton.

Content of dry gold and silver ore sold or treated in Arizona in 1923

County	Ore	Gold	Silver	Copper
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*
Cochise	2,954	1,588.01	31,367	27,433
Mohave	69	17.54	514	9
Pima	28	4.51	166	93
Yavapai	265,486	33,663.93	862,606	5,178,607
	268,537	35,273.99	894,653	5,206,142

SILVER ORE

Of the silver ore reported by 83 producers, the largest quantity came from 22 producers in Cochise County, principally in the Turquoise and Tombstone districts. This ore averaged $1.96 in gold and 13.07 ounces of silver to the ton and a little copper and lead and was valued at $13.44 a ton.

Content of dry silver ore sold or treated in Arizona in 1923

County	Ore	Gold	Silver	Copper	Lead
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Cochise	44,164	3,858.54	545,092	249,986	20,099
Gila	115	.52	5,060	2,946	----
Graham	1	5.36	290	----	----
Greenlee	12,991	1,080.26	88,632	120	455
Mohave	289	105.20	28,473	4,525	----
Pima	266	4.90	6,620	3,042	6,357
Pinal	3,302	142.96	70,931	30,362	3,618
Santa Cruz	867	20.50	22,362	4,747	----
Yavapai	9,176	1,523.78	162,766	60,634	----
	71,171	6,742.02	930,226	356,362	30,529

COPPER ORE

Of the copper ore mined in Arizona, 12,639,690 tons came from low-grade disseminated deposits worked by five producers near Globe, Ray, Ajo, and Bisbee, where most of the ore was treated. The richer siliceous ore, or that valuable as converter lining, was shipped to the smelters. Similar disseminated copper ore, amounting to 616,222 tons, was mined and milled from the low-grade copper deposits in the Clifton and Morenci camps, Greenlee County. The crude copper ore mined and smelted directly (without previous concentration) amounted to 2,522,229 tons. The total output of copper ore mined and treated in 1923 averaged 14 cents in gold and 0.26 ounce of silver to the ton and 1.87 per cent of copper and was valued in all at $5.86 a ton, compared with $5.55 in 1922.

Content of copper ore sold or treated in Arizona in 1923

County	Ore	Gold	Silver	Copper	Lead
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Cochise	1,675,644	41,960.60	1,485,443	124,121,307	379
Coconino	56		78	12,820	
Gila	8,006,826	8,969.68	671,733	198,425,114	
Graham	43	1.89	919	6,786	
Greenlee	644,746	1,489.79	53,417	28,734,536	
Maricopa	27		42	2,498	
Mohave	831	51.49	11,672	22,133	
Pima	1,849,854	5.00	33,795	43,124,754	3,263
Pinal	2,780,446	3,377.28	281,287	68,556,153	
Santa Cruz	1,998	28.60	12,547	225,810	3,640
Yavapai	1,291,383	50,775.08	1,709,118	142,470,426	
Yuma	80,120	31.80	9,227	6,600,692	
	16,331,974	106,691.21	4,269,278	612,303,029	7,282

LEAD, COPPER-LEAD, AND LEAD-ZINC ORE

Lead ore was mined in 10 counties by 80 producers, who reported an output averaging 81 cents in gold and 9.45 ounces of silver to the ton, 6.93 per cent of lead, and a little copper, valued in all at $19.59 a ton. Most of the output of 20 producers of lead ore in Cochise County came from mines near Bisbee, in the Warren district. In Mohave County five mines produced 36,191 tons of lead ore, the largest part of which was mined in the Owens district. Seven producers in Gila County reported 10,769 tons of lead ore, 15 producers in Santa Cruz County reported 3,673 tons, and seven producers in Yavapai County reported 3,546 tons.

Copper-lead ore (229 tons) was reported from mines in Cochise, Gila, Mohave, Pima, Pinal, and Santa Cruz counties, and a large quantity of lead-zinc ore was shipped from the Warren district, Cochise County.

Content of lead ore sold or treated in Arizona in 1923

County	Ore	Gold	Silver	Copper	Lead
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Cochise	59,802	3,792.90	651,418	838,209	9,535,875
Gila	10,769	332.90	31,489	102,917	3,481,451
Greenlee	58	49.70	307	849	11,420
Maricopa	80	15.50	510	22	23,896
Mohave	36,191	63.45	274,541	3,107	1,197,236
Pima	1,105	43.20	17,185	12,294	299,496
Pinal	78	5.30	1,102	3,162	52,884
Santa Cruz	3,673	54.20	38,803	70,190	1,084,402
Yavapai	3,546	117.98	72,973	4,221	216,512
Yuma	67	38.98	2,206	63	87,948
	115,369	4,514.11	1,090,534	1,035,034	15,991,220

Content of copper-lead ore sold or treated in Arizona in 1923

County	Ore	Gold	Silver	Copper	Lead
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Cochise	18		249	1,142	3,911
Gila	8	0.40	393	916	7,445
Mohave	27		3,290	2,339	8,189
Pima	36	10.84	1,236	4,230	22,747
Pinal	20	.10	884	3,113	19,004
Santa Cruz	120	5.40	9,131	11,116	39,823
	229	16.74	15,183	22,856	101,119

GOLD

Of the total gold output 48 per cent was recovered from ore and tailings treated in gold and silver mills, and nearly 46 per cent consisted of gold in crude ore shipped to smelters. From ores treated in mills by amalgamation gold valued at $15,951 was recovered, and from ores treated by cyanidation $2,935,939. Concentrates contained $362,871, against $136,379 in 1922, and ores shipped directly to smelters contained $2,797,144, against $1,260,989 in 1922. The chief gold-producing districts were the San Francisco district, Mohave County, where siliceous gold ores were produced, and the Verde district, Yavapai County, and Warren district, Cochise County, where copper ores were produced.

Of the mines producing gold the United Eastern was first, with 94,748.03 ounces, and the United Verde, at Jerome, was second. The Calumet & Arizona, at Bisbee; the Tom Reed, at Oatman; the Copper Queen, at Bisbee; and the Gold Road, at Oatman, made the next largest outputs of gold.

SILVER

The decline in the price of silver was felt particularly by the producers of copper at Bisbee and Jerome. Tombstone's rush in silver production ended with the Pittman Act. The largest increase in silver was recorded in Yavapai County. Bullion from gold and silver ores contained 247,295 ounces of silver recovered by cyanidation and 306 ounces recovered by amalgamation. Concentrates contained more than 15 per cent of the total output of silver, and crude ore shipped to smelters more than 81 per cent.

Of the total silver 63 per cent came from the ore of the United Verde, Copper Queen, Calumet & Arizona, Tombstone, and Shattuck-Arizona mines.

COPPER

The output of copper in 1923 increased 55 per cent and was the largest since 1918. Nearly all the large copper producers in Arizona increased their output during the early months of 1923, thus taking advantage of the price of copper, which rose to 17½ cents a pound in March. The price steadily declined later until it reached the low point of 12⅜ cents a pound in November. This discouraging condition, occurring in the face of intense domestic consumption of copper and its alloys and the wider application of the metal in industry in America, is explainable solely on the ground of overproduction. The policy of conserving ore rather than selling it at a low price was adopted by most of the large producers, and every effort among high and low cost producers alike was made to reduce costs and improve extraction. Of the total copper 48 per cent was contained in concentrates, 45 per cent in shipping ore, and 6 per cent in ore leached. Of the output from crude ore smelted Yavapai County produced more than 51 per cent and Cochise County nearly 38 per cent. The copper from ore milled came principally from Gila County. The low-grade disseminated ores in Pima, Pinal, and Gila counties yielded 252,047,126 pounds of copper, compared with 191,854,773 pounds in 1922. Similar low-grade copper deposits were worked in Greenlee County, so that the total production from the

disseminated deposits in Arizona was 295,635,782 pounds. In 1922 these ores altogether produced 206,030,072 pounds of copper.

Ten properties, each yielding more than 27,000,000 pounds, produced 92 per cent of the total quantity of copper. The United Verde was first, followed by the Inspiration, Copper Queen, Miami, Ray Consolidated, United Verde Extension, New Cornelia, Calumet & Arizona, Phelps Dodge mine at Morenci, and Old Dominion.

LEAD AND ZINC

The largest yield of lead was in silver-lead ore produced at the Copper Queen mine, at Bisbee, Cochise County, which was followed by mines in Gila, Mohave, and Santa Cruz counties.

All the zinc output came from the Copper Queen mine. About 1,300 tons of lead-zinc ore was shipped to an oxide plant.

MINING INDUSTRY

Increased production, resulting from better labor supply, the alteration and improvement of existing metallurgical plants, and the completion of new plants in Arizona, helped to offset any condition caused by the lower price of copper and silver during the last half of 1923. An effort was made to procure an adequate supply of workers the first part of the year by announcing the higher scale of wages that took effect in March.[2] By this increase miners were paid $5.45 and muckers $4.84 a shift. Other classes of labor were increased 10 per cent, and altogether about 16,000 mine employees in Arizona were benefited. As a result of the lower price of copper and silver, this improvement lasted only until November, when wages were reduced approximately 9 per cent, to $4.95 a shift for miners, $4.40 for muckers, and $5.23 for mechanics. An effort to get lower freight rates on copper bullion did not succeed. The rate on bullion from common points to New York was $16.50 a ton. The rail and water rate through Galveston was $14.50 a ton February 27, 1923, but on August 25 it was reduced to $12.50 a ton, and the minimum weight was 60,000 pounds, under which wharfage, unloading, and loading charges at Galveston and New York were absorbed.

METALLURGIC INDUSTRY

There were 41 active milling plants in Arizona in 1923. In 18 of them concentration devices were used, and 15 adopted the flotation process; 11 mills were equipped for amalgamation, 10 for cyanidation, and 1 for amalgamation and concentration. The leaching of copper ore was continued at Ajo, Pima County. One of the noteworthy improvements in milling was the simplification of flow sheets, especially in the mill of the Miami Copper Co., where tables and vanners have been eliminated. Companies in litigation over oil-flotation patents have come to terms, less oil is used, and better operating results are being obtained. A new smelter of the Magma Copper Co., at Superior, which was under construction during 1923, was expected to be completed for operation in 1924. Five roasters, one reverberatory, and two small converters of the Great Falls type

[2] Eng. and Min. Jour.-Press, Mar. 4, 1923. p. 551.

are provided. At Douglas the Calumet & Arizona smelter was remodeled at a cost of $500,000.

Several concentrating plants were completed in 1923 or were to be finished in 1924. These include the 4,000-ton Copper Queen concentrator, near Bisbee, and the No. 6 concentrator of the Phelps Dodge Corporation, at Morenci, which is being remodeled and enlarged to treat 4,500 tons a day. The 5,000-ton flotation plant at Ajo, under construction in October, 1922, and the present leaching plant are expected to produce 8,000,000 pounds of copper a month. Heap leaching was adopted at the Copper Queen mine, at Bisbee, and the 5,000-ton heap at the United Verde mine, at Jerome, is being successfully treated. The ore at Jerome is a dense sulphide that averages 2.5 per cent of copper to the ton, 36 per cent of iron, and 40 per cent of sulphur. An analytical study of heap leaching by A. W. Hudson and G. D. Van Arsdale [3] was recently published.

Gold and silver produced at mills in Arizona in 1923

County	Ore (short tons)	Bullion (fine ounces) recovered from ore by—				Total value
		Amalgamation		Cyanidation		
		Gold	Silver	Gold	Silver	
Cochise	6,875	29.26	15	56.54	40,619	$35,094
Gila	87	63.26	16	.02	123	1,422
Greenlee	11,450	.44		971.16	65,643	73,912
Maricopa				[a] 637.71	[a] 1,439	14,363
Mohave	186,783	313.26	140	[b] 135,128.96	[b] 68,769	2,856,344
Pima	70	62.45	27			1,313
Pinal	97	63.00	20			1,319
Santa Cruz	160	8.00	2	40.50	559	1,462
Yavapai	[c] 24,283	165.12	74	5,185.44	70,116	168,162
Yuma	67	66.84	12	5.73	27	1,532
	229,872	771.63	306	142,026.06	247,295	3,154,923

[a] Bullion from 14,287 tons of old tailings.
[b] Includes bullion from 60 tons of old tailings.
[c] Also yielded 19 tons of siliceous concentrate and 23 tons of lead concentrate.

Concentration reduced 12,037,653 tons of ore to 782,357 tons of concentrates.

Mine production of metals from Arizona concentrates in 1923

By counties

County	Ore to concentrating mills	Concentrates produced	Gold	Silver	Copper	Lead	Total value of concentrates
	Short tons	*Short tons*	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	
Cochise	615,185	125,550	4,518.37	71,227	19,083,759	224	$2,957,138
Gila	7,858,546	358,877	6,606.22	349,345	180,967,870		27,025,303
Greenlee	616,222	55,298	1,285.00	50,600	24,504,897		3,670,275
Mohave	36,878	1,696	77.72	280,821	19,255	1,097,554	311,539
Pinal	2,759,417	210,902	2,737.08	215,869	65,514,891		9,864,282
Yavapai	84,215	17,919	2,329.48	142,141	4,048,507	163,718	771,302
Yuma	67,190	12,115		6,888	5,417,765		802,059
	12,037,653	782,357	17,553.87	1,116,891	299,556,944	1,261,496	45,401,898

By kinds of concentrates

Dry and siliceous	392	156.04	13,784	3,341		$15,020
Copper	780,261	17,337.55	777,519	299,547,445		45,029,440
Lead	1,704	60.28	325,588	6,158	1,261,496	357,438

[3] Min. and Met., February, 1923, p. 88.

Mine production of metals from Arizona concentrates in 1923—Continued

Average content

Kind of concentrates	Concentrates	Gold	Silver	Copper	Lead	Total value
	Short tons	*Fine ounces per ton*	*Fine ounces per ton*	*Per cent*	*Per cent*	
Dry and siliceous	392	0.40	35.16	0.43		$38.32
Copper	780,261	.02	1.00	19.20		57.71
Lead	1,704	.04	191.07	.18	37.02	20.98
	782,357	.02	1.43	19.14	.08	58.03

Of the material smelted the copper ores constituted the largest part. The Verde district, in Yavapai County, produced more than 49 per cent. The dry and siliceous ores formed the next largest quantity, followed by lead ore.

Mine production of metals from Arizona crude ore shipped to smelters in 1923

By counties

County	Crude ore to smelter	Gold	Silver	Copper	Lead	Recoverable zinc	Total value
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
Cochise	1,161,921	46,652.65	2,600,937	106,020,442	9,711,097	519,103	$19,397,245
Coconino	56		78	12,820			1,949
Gila	154,289	2,697.26	359,207	17,452,149	3,488,896		3,159,996
Graham	44	7.25	1,209	6,786			2,139
Greenlee	30,124	363.59	26,113	4,230,608	11,875		651,659
Maricopa	141	65.14	617	2,722	23,896		3,926
Mohave	556	325.18	38,294	13,142	107,871		47,606
Pima	43,306	68.45	57,489	4,773,562	300,204		771,283
Pinal	24,497	832.80	138,505	3,077,899	75,506		588,525
Santa Cruz	5,468	97.20	77,709	307,116	934,302		176,277
Yavapai	1,485,770	84,130.54	2,667,394	143,669,985	63,235		25,050,311
Yuma	13,005	71.78	4,553	1,182,990	87,948		185,273
	2,919,177	135,311.84	5,972,105	280,750,221	14,804,830	519,103	50,036,189

By kinds of ore

Dry and siliceous	320,796	41,471.63	1,705,977	5,563,086	30,529		$3,076,107
Copper	2,522,229	89,353.66	3,491,752	274,142,937	7,282		45,009,863
Lead	74,611	4,469.80	759,218	1,021,562	14,515,152		1,881,187
Copper-lead	228	16.75	15,158	22,636	100,810		23,159
Lead-zinc	1,313				151,057	519,103	45,873

Average content

Kind of ore	Crude ore to smelters	Gold	Silver	Copper	Lead	Recoverable zinc	Total value
	Short tons	*Fine ounces per ton*	*Fine ounces per ton*	*Per cent*	*Per cent*	*Per cent*	
Dry and siliceous	320,796	0.13	5.32	0.87			$9.59
Copper:							
Oxidized	324,635	.02	2.01	6.61			21.48
Sulphide	2,197,594	.04	1.29	5.26			17.31
Lead:							
Oxidized	70,379	.06	9.90	.67	9.17		24.13
Sulphide	4,232	.07	14.81	1.00	19.03		43.23
Copper-lead:							
Oxidized	53	.20	27.55	5.00	25.03		76.45
Sulphide	175	.04	78.27	4.95	21.22		109.18
Lead-zinc: Oxidized	1,313				5.75	19.77	34.94
	2,919,177	.05	2.04	4.81	.25		17.14

REVIEW BY COUNTIES

GENERAL FEATURES

Mine production of gold, silver, copper, lead, and zinc in Arizona in 1923

County	Gold					Silver	
	Placers		Deep mines		Total value	Fine ounces	Value
	Fine ounces	Value	Fine ounces	Value			
Cochise	15.43	$319	51,274.36	$1,059,935	$1,060,254	2,713,630	$2,225,177
Coconino						78	64
Gila			9,366.75	193,628	193,628	708,691	581,127
Graham			7.26	150	150	1,209	991
Greenlee	68.35	1,413	2,620.19	54,164	55,577	142,367	116,741
Maricopa	20.27	419	702.84	14,529	14,948	2,058	1,687
Mohave	8.42	174	135,845.12	2,808,168	2,808,342	388,024	318,180
Pima	29.80	616	130.90	2,706	3,322	59,036	48,409
Pinal	14.61	302	3,632.87	75,098	75,400	354,398	290,606
Santa Cruz			145.70	3,012	3,012	83,001	68,061
Yavapai	216.96	4,485	91,810.58	1,897,893	1,902,378	2,879,763	2,361,406
Yuma	54.47	1,126	144.35	2,984	4,110	11,487	9,419
	428.31	8,854	295,680.92	6,112,267	6,121,121	7,343,742	6,021,868

County	Copper		Lead		Recoverable zinc		Total value
	Pounds	Value	Pounds	Value	Pounds	Value	
Cochise	125,238,166	$18,410,010	9,711,321	$679,792	519,103	$35,299	$22,410,532
Coconino	12,820	1,885					1,949
Gila	198,531,893	29,184,188	3,488,896	244,223			30,203,166
Graham	6,786	998					2,139
Greenlee	28,735,505	4,224,119	11,875	831			4,397,268
Maricopa	2,722	400	23,896	1,673			18,708
Mohave	32,397	4,762	1,205,425	84,380			3,215,664
Pima	43,144,413	6,342,229	331,863	23,230			6,417,190
Pinal	68,592,790	10,083,140	75,506	5,285			10,454,431
Santa Cruz	311,863	45,844	1,127,865	78,951			195,868
Yavapai	147,718,492	21,714,618	226,953	15,887			25,994,289
Yuma	6,600,755	970,311	87,948	6,156			989,996
	618,928,602	90,982,504	16,291,548	1,140,408	519,103	35,299	104,301,200

Ore sold or treated, number of deep mines producing, and average value of ore per ton in Arizona in 1922 and 1923

County	Ore sold or treated, 1923 (short tons)		Number of deep mines producing		Average total value per ton [a]		Average value per ton in gold and silver [a]	
	Total	Increase	1922	1923	1922	1923	1922	1923
Cochise	1,784,141	942,414	36	50	$17.50	$12.56	$4.05	$1.84
Coconino	56	56		1		34.80		1.14
Gila	8,017,798	1,751,521	25	27	3.82	3.77	.12	.10
Graham	44	30	1	4	40.57	48.61	5.64	25.93
Greenlee	657,796	400,970	4	12	7.66	6.68	.21	.26
Maricopa	14,428	12,675	10	5	4.94	1.27	4.23	1.12
Mohave	224,277	39,087	38	39	12.41	14.34	12.28	13.94
Pima	1,851,359	505,747	31	37	2.75	3.47	.02	.03
Pinal	2,784,011	1,585,698	31	37	3.22	3.75	.06	.13
Santa Cruz	6,738	3,245	29	29	31.59	29.07	15.36	10.55
Yavapai	1,594,268	992,879	69	62	19.54	16.30	2.34	2.67
Yuma	80,262	34,811	11	14	11.30	12.32	.34	.15
	17,015,178	6,269,133	285	317	5.85	6.13	.75	.71

[a] Placer product excluded.

COCHISE COUNTY

All the metals produced in Cochise County increased in quantity in 1923. There were 51 active producers, 14 more than in 1922. The value of the output of silver decreased from $2,655,673 to $2,225,177, gold increased from $755,733 to $1,060,254, copper from $10,790,340 to $18,410,010, lead from $520,870 to $679,792, zinc from $12,006 to $35,299. Ore of smelting grade (1,161,921 tons) predominated and averaged $16.69 a ton. The total content of each metal is given in the table on page 522. Of the ore smelted, 1,060,467 tons was classified as copper ore, of which 280,843 tons was estimated to be oxidized ore and 779,624 tons sulphide ore. All the lead ore smelted (59,794 tons) was shipped to plants outside the State and contained 3,788.55 ounces of gold, 651,408 ounces of silver, 838,209 pounds of copper, and 9,535,651 pounds of lead. All but 1,175 tons of this ore was oxidized. Milling ore produced 125,549 tons of copper concentrate and 1 ton of lead concentrate, which were also shipped. A small placer output was reported by one operator.

California district.—Lead-silver ore was shipped from replacement deposits in limestone in Turkey Creek canyon, 1½ miles northeast of Paradise. The Blue Ribbon, Rimski, Horace, and Malachite groups of claims are on this deposit, which is developed by several adits, the longest 475 feet long. Most of the ore is sulphide with a siliceous gangue, and the ore reserves are estimated at 60,000 tons carrying 2 ounces of silver to the ton and 12 per cent of lead. The main outlet for the product of the district is at Rodeo, N. Mex., which requires a haul of 17 miles. Small lots of lead ore were shipped from the Hilltop Extension and some copper ore from the Willie Rose property.

Cochise district (Johnson, Dragoon).—Copper-lead ore amounting to 52 tons was shipped from the Cochise district by three operators in 1923. Lessees operated the Lady Rose group of the Centurion Mining Co. The property has an inclined shaft 660 feet deep and 3,000 feet of drifts. It is said that 200,000 tons of ore containing 2.8 per cent of copper, most of it oxidized, has been developed.

Dos Cabezas district.—The output of ore from three properties in the Dos Cabezas district amounted to 292 tons, which had a value of $2,166 for gold, silver, and copper. Considerable mineral ground is held by the Central Copper Co. of Arizona, which has extensively developed the Mascot Consolidated ground and has consolidated several other groups of claims, locating the larger part of the mineralized area of the Dos Cabezas district. In 1923 the company reported development work amounting to 3,504 feet, which probably includes the diamond-drilling operations, amounting to 1,584 feet. According to the statement by the company, the property is developed by 33,106 feet of shafts and tunnels and 35,000 feet of diamond-drill work. It has four vertical shafts, each 400 feet deep. The company estimates an ore reserve of 1,087,000 tons, containing approximately 3.72 per cent of copper. The mines are connected with the Southern Pacific Railroad by a branch of the Mascot & Western Railway and an aerial tramway 10,500 feet long. The Twin Peaks Mining Co., operating the Dives mine, reported the

treatment of a large lot of siliceous gold ore, from which gold and silver bullion was recovered by amalgamation in a 10-stamp mill equipped with one concentrating table. The property is opened by a vertical shaft 100 feet deep and has a tunnel 960 feet long. It is said that the property has 10,000 tons of ore averaging $6.50 in gold and silver to the ton, which is available for immediate treatment. One lot of gold and silver ore was shipped from the Gold Prince group by lessees.

Hartford district.—The Alto Mining & Milling Co., which owns property 12 miles from Hereford, conducted experiments in a 5-stamp mill to find a method of treating the ore. The output of the district by four operators was valued at $581 and included a little placer gold.

Swisshelm district (*Webb*).—In the course of development work at the Four Horse mine sulphide and oxidized lead ore was shipped.

Teviston district.—One small lot of oxidized lead ore was shipped from the Tennessee claim, 12 miles southeast of Willcox.

Tombstone district.—Twenty producers of ore in the Tombstone district reported the output of 32,770 tons, containing $63,924 in gold, 495,943 ounces of silver, 195,485 pounds of copper, and 465,914 pounds of lead, valued in all at $531,947. The output includes 6,675 tons of ore treated by cyanidation and 110 tons of old tailings shipped to the smelter. The Bunker Hill mines, operated by lessees, produced lead-silver ores, which were shipped to the smelter at El Paso, Tex., and silver ore, which was shipped to the Copper Queen smelter, at Douglas. Silver ore was also shipped from the Argenta, Bob Ingersoll, Josie, Old Guard, Rocky Bar, Side Wheel, and Sunset properties. The 50-ton mill on the Bonanza property was leased, and the operators treated considerable ore by cyanidation. One lot of 500 tons of ore was said to average $40 a ton in silver. The ore came from numerous veins that are exposed at the surface, as well as from dump ore stacked at one of the shafts. Smaller operations were carried on by the Old Pueblo Leasing Co. until May, after which work ceased. Seventy leases were operated at the property of the Bunker Hill Mines Co.,[4] and a total of 22,884 tons of ore was shipped, the lead ores to the smelter at El Paso, Tex., and the remainder of the output to the copper smelter at Douglas. Of this output 75 per cent was shipped during the first seven months of 1923, but after the termination of the Pittman Act, with only 27 formal leases operating, there was practically no profit either for the lessees or for the Bunker Hill Co. The largest output of ore was made from the Oregon, Lucky Cuss, and Silver Thread mines. More than 5,000 feet of shafts, winzes, and raises were completed by the lessees.

Turquoise district (*Courtland*, *Pearce*, *Gleeson*).—The output of the Turquoise district consisted of 23,069 tons of shipping ore, containing $39,372 in gold, 142,535 ounces of silver, 1,139,644 pounds of copper, and 695,048 pounds of lead, valued in all at $372,432. About half the output was gold and silver ore from the Commonwealth mine. Most of the remainder, consisting of copper ore, came from the Germania, Great Western, and Leadville mines. Considerable

[4] Phelps Dodge Corporation Ann. Rept. for year ending Dec. 31, 1923.

oxidized lead ore and dry siliceous silver ore was produced from the Tejon mine, and oxidized lead ore from the Silver Bill property.

Warren district (*Bisbee*, *Lowell*, *Warren*).—Most of the ore in the Warren district is mined from the Copper Queen and Calumet & Arizona properties, and a large part of the output is directly smelted at the two smelters at Douglas connected with these properties. In 1923 about half the ore output of the Copper Queen mine was milled at Bisbee, and the concentrates were shipped with the ore to the smelter at Douglas. The Night Hawk Leasing Co. did considerable development work on ground in the Copper Queen territory and produced a large quantity of copper ore. At the Shattuck-Arizona property operations were resumed in February, and oxidized lead ore and copper ore were shipped to the smelters at Douglas and El Paso. Altogether the mines in the Warren district produced 1,727,694 tons of ore, containing $953,997 in gold, 2,072,377 ounces of silver, 123,884,382 pounds of copper, 8,442,252 pounds of lead, and 519,103 pounds of zinc, with a total value of $21,490,607. The zinc ore was shipped to smelters in Oklahoma.

At the Copper Queen branch of the Phelps Dodge Corporation the west porphyry ore body of Sacramento Hill was put on a producing basis, and the concentrator at Warren started operations April 2. In October, after several months' operation, the steam shovels and other equipment at the pit were found adequate to furnish the necessary ore to the mill, which has a capacity beyond that estimated and gives most satisfactory results. The upper portion of the ore deposit is said to be interspersed with horses of waste, thus causing the lowering of the grade, and it will probably be another year before there is an improvement in the average grade of the mill heads. To the end of 1923 about 800,000 tons of low-grade ore from Sacramento Hill had been segregated and piled in heaps in the valley near Don Luis, the plan being to leach this ore with the strongly acid-impregnated waters from the mine and precipitate the copper from the solution on iron. A total of 1,481,671 solid yards of ore and waste was removed from Sacramento Hill. Of this amount 1,005,842 yards went to the waste dump, and 434,239 tons, assaying 0.93 per cent of copper, was added to the leach dump. The mill received 596,384 tons, the stock pile 39,519 tons, and the smelter 17,564 tons. Underground work was confined as much as possible to the Southwest and Sacramento divisions in order to obtain the advantage of centralization. Lead-silver ore was profitably mined on company account, although the expiration of the Pittman Act in June and the consequent drop in the price of silver caused considerable curtailment in operations for the last half of 1923. Lead-zinc ore was shipped by lessees from the Lowell mine, and lessees also worked small irregular outlying ore bodies that could not be successfully handled on company account. A considerable increase in this class of mining was noted in 1923, but on account of the low price of copper two leasing companies, the Night Hawk and Boras, discontinued production November 22 and December 31, respectively. The annual report for the Copper Queen branch of the Phelps Dodge Corporation showed production to be as follows:

Ore and metals contained in output of Copper Queen mines, 1923

Kind of material	Total	Gold	Silver	Copper	Lead	Zinc
Underground:						
Company:	*Short tons*	*Ounces*	*Ounces*	*Pounds*	*Pounds*	*Pounds*
Copper ore	371,541	7,168	343,875	49,321,995		
Silver ore	644	59	10,288	4,960		
Lease: Copper ore	125,958	5,386	188,186	12,356,456		
Company: Lead ore	17,194	1,251	221,050	10,421	2,819,195	
Lease: Lead ore	16,038	191	93,746	945,492	3,272,420	
Lease: Lead-zinc ore	1,313				215,797	610,709
Sacramento Hill:						
Company:						
Smelting ore	17,564	354	5,035	1,648,578		
Milling ore	635,903	4,717	72,186	23,267,904		
Lease:						
Copper ore	3,261	25	1,356	246,473		
Precipitates	154		7	133,055		
	1,189,570	19,151	935,729	87,935,334	6,307,412	610,709

The Calumet & Arizona mines[5] produced 477,312 dry tons of ore, of which 439,959 tons, containing 4.62 per cent of copper, was treated at the company's smelter at Douglas, 36,690 tons was exchanged with the Copper Queen smelter, and 10,667 tons of low-grade copper ore high in sulphur was treated at the Old Dominion smelter, at Globe. Shipments of silver-lead ore to El Paso, Tex., amounted to 3,630 tons. Owing to the change of ores from oxides to sulphides in the mines at Bisbee the company has had to resort entirely to reverberatory smelting at Douglas, where a total of 575,812 dry tons of ore, including 150,054 tons of custom ore, was treated in 1923. The Briggs, Junction, Cole, and No. 3 mines were operated. A large area of high-grade oxide ore and leached material has been developed in the west-central portion of the Ormond claim. In one place the ore has been stoped for 50 feet above the level. In a raise from the 1,500-foot level of the Baton Rouge claim 80 feet of gold-silver ore was developed. Sulphide ore 35 to 40 feet in width, averaging 4.5 per cent of copper, was developed on the 1,700-foot level of the Last Rose of Summer claim. A large mass of pyrite extends north and south with this ore on the 1,700-foot level, and the 1,800-foot level is being driven out under this area. During 1923 water was pumped from the Junction mine at the average rate of 3,188 gallons a minute. Before pumping began the acid water from the Copper Queen and Oliver mines was neutralized with an average of 2,100 pounds of lime daily. Altogether the production of metal from company and custom ore amounted to 42,374,638 pounds of refined copper, 1,084,606 ounces of silver, and 38,581.51 ounces of gold. Dividends were distributed to stockholders amounting to $2,248,849.

The Shattuck property[6] was operated at reduced capacity and produced 25,089 dry tons of copper ore of smelting grade, from which were recovered 3,223,209 pounds of copper, 157,124 ounces of silver, and 1,349 ounces of gold. The lead ore, with some siliceous ore, amounted to 18,499 dry tons, which contained 1,590,682 pounds of lead, 164,354 ounces of silver, and 1,023 ounces of gold. The operating cost for copper was 11.477 cents a pound and for lead

[5] Calumet & Arizona Mining Co. Ann. Rept. for 1923.
[6] Shattuck Arizona Copper Co. Ann. Rept. for 1923.

13.893 cents, and the net operating costs were 6.926 cents and 4.61 cents, respectively. The copper ore was mined from the 100 and 600 foot levels, and the lead stopes on the 300-foot level were reopened and produced considerable ore.

COCONINO COUNTY

One lot of oxidized copper ore, some of which assayed as high as 25 per cent of copper and 3 ounces of silver to the ton, was shipped from the Anita & Emerald group.

GILA COUNTY

There were 27 producers in Gila County, one less than in 1922, but the output of ore increased from 6,266,277 to 8,017,798 tons, of gold from $142,290 to $193,628, of silver from 579,714 to 708,691 fine ounces, and of copper from 170,226,627 to 198,531,893 pounds. Lead decreased from 4,344,611 to 3,488,896 pounds. The total value increased from $23,941,552 to $30,203,166.

Some copper ore was treated at Globe and Miami, but the lead ores and part of the copper ores were shipped to smelting plants outside of the county. Of the copper ore smelted 124,055 tons was sulphide and 19,349 tons oxidized. The 154,289 tons of smelting ore shipped had an average value per ton of $20.48, and 358,877 tons of concentrates, all copper, an average value per ton of $75.31.

Banner district.—The largest producer of ore in the Banner district was the Seventy-nine Mining Co., 4 miles south of Winkelman, whose ore contained principally lead and silver with a little gold. The company operated until August 1, when the mine was closed by litigation. The ore reserves in the property are estimated at 50,000 tons.

Dripping Springs district.—One small lot of gold bullion was recovered from ore treated in the Dripping Springs district.

Globe district (Miami).—Twenty mine operators in the Globe district reported the production of 8,006,991 tons of ore, containing $185,535 in gold, 673,686 ounces of silver, 198,426,127 pounds of copper, and 26,531 pounds of lead, valued in all at $29,908,456. Most of the ore was concentrated and yielded 358,877 tons of copper concentrate, which, with 143,562 tons of crude ore, was directly smelted. The greater part of the ore was treated at smelting plants in the district, but part of it was shipped to El Paso, Tex. Copper ores were also treated experimentally by leaching. Most of the ore was mined from the Inspiration property, which produced 5,146,750 tons, and from the Miami, 2,380,155 tons. Ore from both these mines was concentrated, and the concentrate was treated at the International smelter, at Miami. Other properties producing notable quantities of copper ore were the Arizona Commercial, Iron Cap, Old Dominion, Gibson Consolidated, and Superior & Boston.

Operations were continuous throughout 1923 at the Inspiration property,[7] and the average monthly production was 7,406,751 pounds of copper. The ore mined averaged 1.192 per cent of copper. This average grade may be improved in 1924, as the Live Oak section,

[7] Inspiration Consolidated Copper Co. Ann. Rept. for 1923.

which has ore of higher grade, was expected to be producing in July. More than $5,000,000 will have been expended in the development of the Live Oak ore body, the sinking and preparation of the Porphyry shaft, the surface equipment and extension of the railroad to handle the ore, and the construction of the town site to house the employees. The total ore mined from the Inspiration, Warrior, and Live Oak sections amounted to 5,135,115 tons, of which 5,050,425 tons was Inspiration ore averaging 1.175 per cent of copper, 15,509 tons was Warrior ore averaging 6.49 per cent, and 69,181 tons was Live Oak ore averaging 1.848 per cent. Nearly all the ore (5,111,465 tons) was concentrated, 18,773 tons was directly smelted, and 4,876 tons was treated at the experimental leaching plant. The total production of copper was 88,881,012 pounds from 5,146,750 tons of ore. The assay of the mill feed to the concentrator was 1.175 per cent of copper, of which 0.249 per cent was oxidized copper. The general mill tailing contained 0.231 per cent of copper. The ratio of concentration was 31 tons of ore into 1 ton of concentrate, of which the average smelter assay was 27.15 per cent of copper. The flotation concentrate contained 32.24 per cent of copper and the table concentrate 9.28 per cent. The recovery of sulphide copper in ore was 92.48 per cent. The cost of fine copper produced, including depreciation but excluding depletion and Federal taxes, amounted to 11.6158 cents a pound. Dividends amounting to $2,363,934 were paid to stockholders.

From the Miami property[8] 2,378,655 tons of ore was mined, mostly from stoping the main ore body. Five of the six mill sections were operated at full capacity and treated 2,380,155 tons, or an average of 6,624 tons of ore a day for the 359⅓ days the mill was in operation. The total refined copper produced from this ore was 64,448,345 pounds, amounting to an average monthly production of 5,370,695 pounds. Part of the results of these operations are set forth in the company's report as follows:

> The entire tonnage stoped was produced by the undercut caving method of mining, and mining costs advanced approximately 12 cents per ton, or 0.9 cent per pound of copper over cost of the previous year. The greater part of the increased cost per ton was due to wage advances which resulted in an average wage for the entire plant in 1923 of $5.426 per shift, as compared with $4.774 per shift in 1922. * * *
>
> Ore milled, 2,380,155 tons, at 1.697 per cent copper.
>
> Concentrate produced, 80,807 tons, at 41.977 per cent copper.
>
> Copper in concentrate, 67,840,363 pounds.
>
> Copper per ton ore, 28.503 pounds.
>
> Mill extraction, 83.98 per cent.
>
> The cost of milling ore to the point of concentrate on board cars is as follows:

Direct crushing expense	$0.30329
Direct concentrating expense	.21911
Tailing and concentrate handling	.04874
Water for concentrating	.04018
Miscellaneous expense	.00971

> The total milling cost decreased about 2.3 cents per ton of ore as compared to the previous year, entirely due to a lower power cost resulting from drop in the price of California fuel oil. * * *

[8] Miami Copper Co. Ann. Rept. for 1923.

As a considerable amount of new development was performed in the high-grade sulphide ore bodies, a new estimate was made of both the tonnage and grade of this ore as of January 1, 1924. Development during the year added 308,133 tons to these reserves, and mining operations during the year extracted 420,978 tons from outside the previously estimated boundary, which has the effect of adding that amount also to the high-grade sulphide ore reserves, or a total addition during the year of 729,111 tons. There was practically no development work done in the mixed sulphide and oxide ore body or in the low-grade ore body during the year, and these tonnages remain as previously reported.

Exploration work is being prosecuted in the territory east of the Miami fault, which has been dropped down considerably below the corresponding horizons containing ore bodies on the west side of the fault. Some ore of good grade has been penetrated by diamond drills, but as yet there is no basis for an estimate of any tonnage in this territory.

On January 1, 1924, the ore reserves stand as follows:

High-grade sulphide ore, 5,106,643 tons at 2.08 per cent copper.
Mixed sulphide and oxide ore, 6,000,000 tons at 2.00 per cent copper.
Low-grade sulphide ore, 36,000,000 tons at 1.06 per cent copper.

The Superior & Boston mine [9] produced 22,006 dry tons of ore averaging 3.88 per cent of copper and 9.35 ounces of silver to the ton during the fiscal year ending September 30, 1923. This ore contained 1,709,670 pounds of copper and 205,659 ounces of silver, for which the company received $272,689.79, or an average of $12.39 a ton, after smelting and freight charges were deducted. Of the total output 53 per cent was produced from the Footwall vein, 30 per cent from the Rigby vein, 16 per cent from the North or Old Dominion and Dewey veins, and 1 per cent from the Great Eastern vein. The quantity of water pumped from the mine decreased from 120,000 to 90,000 gallons a day.

At the Old Dominion property [10] operations were continued without interruption. Of the 289,695 dry tons of ore mined, 78,111 tons was of smelting grade and averaged 7.54 per cent of copper, 207,575 tons was concentrating ore averaging 4.02 per cent, and 4,009 tons was siliceous ore, used for converter lining, averaging 2.64 per cent. The total metal produced, including that from custom ore, amounted to 26,764,801 pounds of refined copper, 190,033 ounces of silver, and 5,137.40 ounces of gold. This output, with the copper on hand, gave a total of 28,443,060 pounds of refined copper, which sold at an average price of 14.25 cents a pound net cash f. o. b. New York. The entire output of oxidized smelting ore came from the west side of the mine, and 22,000 tons of sulphide smelting ore, together with most of the concentrating ore, came from the east side. The following paragraphs are taken from the company's report:

On the twentieth level nearly 700 feet of drifting was done on the Josh Billings vein, which runs parallel to the Old Dominion vein and a short distance in the footwall to the north from it. This shows that the ore shoot is slightly longer but narrower than it was on the nineteenth level. On the eighteenth level a crosscut was run north of the Old Dominion vein for 800 feet. This shows chalcopyrite mineralization for most of the distance, but no bodies of commercial ore were encountered. The physical and chemical characteristics of this ground justify the hope that sometime it may be possible to recover a considerable amount of copper from it at a comparatively low cost by leaching the ore in place.

On the east side of the mine development work was pursued at different points on the sixteenth level down to the twentieth level, proving extensions

[9] Superior & Boston Copper Co. Ann. Rept. for year ending Sept. 30, 1923.
[10] Old Dominion Co. Ann. Rept. for 1923.

to known ore bodies as well as some new ore. On the sixteenth level the south vein was developed and found to be persistent although rather narrow but containing some excellent ore. This vein is parallel and probably a split from the Old Dominion vein. High-grade chalcopyrite ore was also opened up on the California vein. A great deal of other satisfactory work was done, and although the ore on this side of the mine is classed as concentrating ore, judging from past experience, approximately 180,000 tons will be high enough in grade to ship direct to the smelter.

The most encouraging thing about the ore reserves is that the oxidized smelting ore shows practically no decrease and, with the development of the Block 19 West ore body, the prospects are that this oxidized ore will hold out well in 1924, if it does not show any increase. The mine is in good physical condition, and sinking and unwatering is further ahead than it has been for a great many years.

The Arizona Commercial Co.[11] operated the Copper Hill mine continuously throughout 1923, but the Eureka mine remained idle. The ore produced, amounting to 75,722 tons, was treated at the Old Dominion plant, with the exception of 11,168 tons of siliceous semi-oxidized ore averaging 4.96 per cent of copper, which was shipped to the International plant at Miami. The 63,689 tons of milling ore treated at the Old Dominion concentrator averaged 6.09 per cent of copper, and 865 tons of smelting ore averaged 10.66 per cent of copper. From these ores 8,115,212 pounds of refined copper, 37,826 ounces of silver, and 2,143.63 ounces of gold were recovered. One dividend of $132,500 was paid in 1923, the first since 1918. Ore was mined from every level in the mine, equally divided between territory tributary to No. 1 shaft and to No. 2 shaft. Ore reserves are sufficient for four years' work at the present rate of production.

The Iron Cap mine[12] and mill were operated continuously and produced 6,134,162 pounds of copper and 75,982 ounces of silver from the treatment of 83,931 tons of ore, which was reduced to 12,551 tons of concentrate. The total receipts from the sale of copper amounted to $886,142.32; silver, $59,039.77; gold, $13,239.17; and from other income $20,373.52; or a total of $978,794.78.

Pioneer district.—Silver ore mined from the Old Bob Tail property was shipped to the smelter at Miami.

Richmond Basin district.—Several small lots of silver ore, containing a little copper, were shipped from the Gila Monster property.

GRAHAM COUNTY

Aravaipa district.—The Aravaipa Metal Mines Co. is reported to have shipped one lot of copper ore containing silver.

Lone Star district.—About 10 tons of copper ore was shipped from the Red Mountain and Lindsey No. 2 claims, 9½ miles northeast of Safford. A shipment of similar ore was also made from the Blue Jay property.

Rattlesnake district.—The Long Tom claim, 25 miles south of Klondyke, in the Galiuro Mountains, was operated by lessees and produced a small quantity of silver ore containing gold.

GREENLEE COUNTY

All the metals produced in Greenlee County showed increases in 1923—gold from $19,687 to $55,577, silver from 34,886 to 142,367

[11] Arizona Commercial Mining Co. Ann. Rept. for 1923.
[12] Iron Cap Copper Co. Eleventh Ann. Rept., for 1923.

fine ounces, copper from 14,176,777 to 28,735,505 pounds, and lead, of which none was produced in 1922, 11,875 pounds. The ore increased from 256,826 to 657,796 tons, the total value from $1,968,438 to $4,397,268, and the number of producers from 6 to 14.

Ashpeak district (Duncan).—Considerable silver ore was shipped to El Paso, Tex., from the Ashpeak mine, 11 miles east of Duncan.

Copper Mountain and Greenlee districts (Morenci, Metcalf, Clifton).—Most of the output given above for Greenlee County was that of the Copper Mountain and Greenlee districts. The Phelps Dodge Corporation controls the property formerly owned by the Arizona Copper Co. at Metcalf and Clifton, and the output was derived chiefly from these properties. The Stargo Mines (Inc.) operated its 75-ton cyanidation plant until September 15, when both the mine and mill were closed. Silver bullion containing a little gold was shipped to the mints at San Francisco and Denver. Other properties from which shipments were reported were the Lakenan and Buena Vista mines, which produced silver ore, and the Arizona group of the Greenlee Gold & Vanadium Co., which produced lead ore.

Improvements at the Morenci branch of the Phelps Dodge property,[13] particularly the Humboldt mine, put it in condition for greater production. The No. 6 mill was remodeled and started in May with a new flow sheet, which was expected to increase the capacity from 1,400 to 4,500 tons of ore a day early in 1924. The capacity reached in 1923 was about 2,300 tons a day, and the mill treated 616,222 tons of ore, averaging 2.4 per cent of copper. The recovery of copper from sulphide ore was 91.91 per cent and of total copper 81.91 per cent. From company and lease ore 56,844 tons of concentrate was recovered, containing 24,510,827 pounds of copper. Part of the ore and concentrate produced up to April was shipped to Douglas for smelting, but on May 1 the smelter at Clifton was started. The blister copper produced contained 28,327,635 pounds of copper, 53,241 ounces of silver, and 1,447.90 ounces of gold. The average number of men employed at the Morenci branch was 975.

Mayflower district.—Lead ore containing a little copper and silver was shipped from the Wampum claim, 25 miles northeast of Duncan.

San Francisco River district.—Small lots of placer gold were mined from the gravel of San Francisco River and sold to storekeepers.

MARICOPA COUNTY

At gold and silver mills in Maricopa County 14,287 tons of old tailing was treated, which produced gold and silver bullion valued at $14,363. Ore shipped directly to the smelter, amounting to 141 tons, was valued at $27.84 a ton. A little placer bullion was reported by two operators.

San Domingo district.—Placer ground was worked in the San Domingo district, and several lots of placer gold, which had a fineness of 0.919, were shipped to the mint at San Francisco.

Vulture district.—The Vulture Milling Co. treated a large quantity of old tailing in its 200-ton cyanidation plant. It is estimated

[13] Phelps Dodge Corporation Ann. Rept. for 1923.

that there is still at the Vulture property 150,000 tons of old tailing carrying about $1.50 in gold and silver to the ton, the gold predominating.

White Peak district.—The Prince of Arizona group was operated, and a small lot of lead ore was shipped to the smelter. This property is on the north slope of Snively Butte, 8 miles due north from Beardsley, on the Atchison, Topeka & Santa Fe Railway. A small mill on the property equipped with a Stebbins dry concentrator was idle in 1923. The richer first-class ore shipped to the smelter carried $4.80 in gold and 11 ounces of silver to the ton and contained 44 per cent of lead.

MOHAVE COUNTY

In Mohave County 40 producers, 1 more than in 1922, mined 224,277 tons of ore, a gain of 39,087 tons. The gold increased from $2,100,728 to $2,808,342, the silver from 174,985 to 388,024 fine ounces, and the lead from 233,983 to 1,205,425 pounds; the copper decreased from 78,200 to 32,397 pounds. The total value was $3,215,664, a gain of $916,525.

The ore treated by amalgamation or cyanidation, principally the latter, amounted to 186,783 tons, which yielded $2,799,839 in gold and 68,909 ounces of silver, having a total value of $2,856,344, or an average of $15.29 a ton. The concentrating ores (36,878 tons) yielded 1,696 tons of concentrates, against 787 tons of concentrates from 15,267 tons of ore in 1922. The concentrates in 1923 had a total value of $311,539, or an average of $183.69 a ton. Crude ore shipped to smelters amounted to 556 tons, against 598 tons in 1922, and had a total value of $47,606, or an average of $85.62 a ton.

Cedar Valley district.—The Copper Basin property of the Phelps Dodge Corporation was operated about seven months by lessees, who shipped several lots of copper ore to the smelter at Humboldt.

Chemehuevis district.—Four operators in the Chemehuevis district reported the output of 72 tons of ore, from which gold was recovered by amalgamation. The properties operated were the Dutch Flat, Elsie V., St. Lawrence, and Gold Dollar.

Indian Secret district (White Hills).—Development work was done at the White Hills property, and a lessee shipped a small quantity of silver-lead ore of smelting grade. This property is about 30 miles south of Colorado River and an equal distance north of Chloride, the terminus of a branch of the Atchison, Topeka & Santa Fe Railway.

Maynard district.—Small lots of silver and copper ore were shipped from several claims in the Maynard district. The Sweeney mine produced a little ore carrying bismuth and gold, and the Silver King and Jackman properties were reported as producers.

Owens district.—In 1923 the Signal Mines Co. consolidated the McCracken group with the Senator and Alta properties. The 150-ton concentration-flotation plant erected by the former owners of the McCracken property was used in treating considerable lead ore, and the resulting concentrate, rich in silver, was shipped to the smelter at Midvale, Utah. The Red Top claim, 1 mile south of Fool's Peak, produced several lots of ore containing about 46 per cent of lead with a little silver. Similar ore was shipped from the

Otsego property. Operators of dry placers reported the shipment of a little gold, which was sold to merchants in the vicinity.

San Francisco district (*Oatman, Gold Road, Vivian*).—Twelve producers in the San Francisco district reported the mining and milling of 186,679 tons of ore and the shipment of 7 tons of high-grade ore to the smelter at Humboldt. The milling ore, containing gold with a little silver, came principally from the United Eastern, Tom Reed, and Gold Road properties. The Telluride, Oatman United, and Gold Dust properties also produced gold ore, most of which was treated in a custom mill. At Secret Pass, in the River Range 30 miles west of Kingman, the Orphan group of claims produced free gold ore, which was treated in a 30-ton Lane mill by amalgamation. Gold bullion from these operations was shipped to the mint at San Francisco. The total output of the district amounted to 186,686 tons of ore, containing $2,796,830 in gold and 68,551 ounces of silver, valued together at $2,853,042.

The United Eastern mine[14] produced 104,800 tons of ore, of which the Big Jim claim produced 103,090 tons and the Tom Reed Extension claim 1,710 tons. The last of the ore from the Tom Reed Extension mine was mined above the eighth and ninth levels. Water now stands in No. 2 shaft about 22 feet below the seventh (940-foot) level. Ore from the Big Jim was produced from the main vein above the third, fourth, fifth, and sixth levels, from the United Eastern portion of the Side Line vein, and from the dump. The metal recovery from the Big Jim claim was 93,816.52 ounces of gold and 44,972 ounces of silver, and from the Tom Reed Extension 931.51 ounces of gold and 477 ounces of silver. These figures include the content of tailing-pond skimmings. The gold recovered by cyanidation was valued at $2,048,886.63, and the silver at $36,187.90. The average value of the ore treated was $19,876 and the tailing loss was 85.7 cents, representing a recovery of 95.69 per cent. Direct mining costs averaged $3.54 a ton and direct milling $1.91 a ton, which, with marketing and indirect costs, brought the total cost to $6.76. The net income from operations was $1,269,825. Dividends of $817,800, or 60 cents a share, were paid. The annual report of the company reviews conditions as follows:

> At this time last year some diamond drilling was being done to determine the possibilities of the vein in the Tom Reed Extension claim at a depth of about 2,300 feet below the surface and 1,120 feet below the lower limits of the ore body in that claim. This drill hole passed through the andesite into the underlying granite, and while it showed at about the calculated position of the vein a considerable width of soft and crushed andesite, there was very little quartz and calcite and no commercial ore.
>
> The production of the United Eastern-Tom Reed vein system has been such as to warrant the fullest exploration of the vein within the company's property, with the hope of finding other ore bodies such as have been mined in the company's Tom Reed Extension and Big Jim claims, but our endeavors have not met with success. Some of this exploration has been done by underground mining work, but the major portion has been done by diamond drilling. It is believed the possibilities of the property have been sufficiently investigated, and further exploration expenditures are not justified. In consequence of our inability to find new ore bodies and the maintaining of production at the average rate of 287 tons per day, the general manager's estimate of assured ore reserves as of January 1, 1924, is 27,035 tons, having a gross value of $366,760 and an average value of $13.57 per ton. At the normal rate of production,

[14] United Eastern Mining Co. Ann. Rept., for 1923.

this would not be a four months' supply, so it is expected operations will cease at our Oatman property about June 1, 1924. It is regretted that this has to be, but it should be recognized that mining is a wasting industry and that a mining company can not continue operations indefinitely unless new ore bodies or new properties can be found to take the place of ore bodies which are being mined.

The record of the company's property at Oatman, Ariz., is an unusual one and very gratifying in many particulars. In 1913 Mr. J. L. McIver and Mr. George W. Long, who had been studying the ore occurrences of the Oatman district, reached the conclusion that certain areas had excellent possibilities. They secured options on a number of claims and turned them over to the United Eastern Mining Co., which they caused to be organized on December 3, 1913. By 1916 there had been a sufficient ore development to warrant the installation of a large mill. Milling operations commenced January 4, 1917, and have proceeded since with but minor interruptions. In the seven years, 1917–1923, inclusive, 697,038 tons have been mined and treated, having a gross value of $13,991,577.19 and an average value per ton of $20.073. The average saving effected was 96.62 per cent of the values, a most excellent result. The average operating cost per ton was $8.281. The seven years' operations were all within the period so greatly affected by the high prices caused by and continuing as the result of the war, and it seems reasonable to say that under pre-war prices the average cost would not have exceeded $6 and very probably would have been considerably less. The higher prices which it has been necessary to pay would have therefore meant a difference to the stockholders of probably more than $1,500,000, or approximately $1.20 per share, or two years' dividends at the rate of 60 cents per annum.

The Tom Reed mine, the fourth largest producer of gold in Arizona in 1923, was operated by several sets of lessees who were mining all available ore before the final closing of the property, which was expected to take place in June, 1924.

The Gold Road mines [15] resumed operations early in 1923 and produced 31,109 tons of milling ore. The company reports that considerable exploration was carried on without finding a new ore body. It is probable that all commercial ore remaining in this property will be mined during 1924.

Two small mills were under construction in 1923, one by the Oatman United Gold Mining Co. and the other by the Telluride Mining, Milling & Development Co. The Oatman United mill is designed to treat 75 tons of ore daily by an all-sliming process, including cyanidation and precipitation of gold and silver upon copper plates by electrolysis and recovery of the precipitates on an Oliver filter. The Telluride mill is designed to treat 45 tons of ore a day by the cyanide process. A sorting belt for the removal of waste and washing sprays for cleaning the ore preliminary to sorting are included in the design. In addition, the Gold Dust Mining Co. has rehabilitated a 10-stamp mill on its property and installed a patented centrifugal amalgamator for the recovery of the gold. The three properties mentioned above are said to have ore bodies and sufficient development to begin stoping as soon as their milling arrangements have been completed.

On the Amalgamated property crosscutting is being done. A shaft on the Lucky Boy has reached a depth of about 100 feet. On the North Star a crosscut is being made at the 300-foot level of its 420-foot shaft. The American is under lease. The 250-foot shaft of the Lexington is to be sunk an additional 125 feet and a crosscut extended at the new level. A tunnel about 500 feet long was being driven on the United Republic. Lessees were at work at the Alcyone.

[15] United States Smelting, Refining & Mining Co. Eighteenth Ann. Rept., for 1923.

About 85 properties are listed on the map of the Oatman district.[16] Of this number, 13 were active in 1923. Although distant from railroad transportation, Oatman is accessible by good roads and possesses the advantage that mining and metallurgical practice has been established. The broad features of structural and areal geology have been outlined by Ransome, and the accumulated experience of many can be advantageously applied to future operations. Power from the Kingman Power & Light Co. is available at an average cost of 2.4 cents a kilowatt-hour on a straight meter basis. In view of the fact that this power is transmitted over 36 miles of line and is generated by steam, the power rate is low.

Wallapai district (*Cerbat*, *Chloride*, *Kingman*, *Mineral Park*, *Stockton Hill*).—Twelve producers in the Wallapai district reported the output of 1,150 tons of ore, of which 789 tons (also 60 tons of old tailings) was milled and produced concentrates containing gold, silver, and copper. The ore of shipping grade amounted to 285 tons, which contained 173.42 ounces of gold, 14,354 ounces of silver, 5,395 pounds of copper, and 11,620 pounds of lead. The principal producing mine was the Middle Golconda, owned by the Highland Mining & Milling Co. A concentration mill was built north of the site of the old Golconda mill. Ore was mined from the George Washington, Hibernia, and Tuckahoe properties. Gold ore containing considerable silver was shipped to the smelter at Humboldt from the Memphis group, owned by the Dardanelles Amalgamated Mines (Inc.). This company did 150 feet of drifting and 100 feet of crosscutting during the seven months of its operation. The mine is developed by a 150-foot shaft, and the ores mined are considered sulphide with a siliceous gangue.

Weaver district (*Mocking Bird*, *Virginia*).—A small lot of ore containing gold and silver from the Zeroleene claims was treated in a 3-ton amalgamation mill.

PIMA COUNTY

The value of all metals, except gold, produced in Pima County increased in 1923, and the largest increase was in the output of copper from the low-grade disseminated ores produced in the Ajo district and treated by leaching. The number of producers increased from 36 to 39, the ore from 1,345,612 to 1,851,359 tons, silver from 20,145 to 59,036 fine ounces, copper from 27,126,834 to 43,144,413 pounds, lead from 275,209 to 331,863 pounds, and total value from $3,704,122 to $6,417,190. Gold decreased from $6,718 to $3,322. Ore of shipping grade aggregated 43,306 tons, valued at $771,283. At milling plants 70 tons of ore yielded gold and silver bullion having a total value of $1,313. The placer output amounted to $616 in gold and 7 ounces of silver.

Ajo district.—The output of the New Cornelia mine,[17] the only producer in the Ajo district, amounted to 1,805,322 tons of carbonate ore, averaging 1.53 per cent of copper, which was treated at the leaching plant. Electrolytic copper amounting to 36,063,832 pounds and copper in cement amounting to 2,303,886 pounds were produced.

[16] Ransome, F. L., Geology of the Oatman gold district: U. S. Geol. Survey Bull. 743, 1923.

[17] New Cornelia Copper Co. Ann. Rept. for 1923.

The copper sold, 37,083,541 pounds, brought 14.5487 cents a pound. Dividends paid to stockholders amounted to $1,350.000, which included $450,000 from "reserve for depletion." The first unit of the 5,000-ton concentrator was put into operation January 8, 1924, but the first ore was delivered and crushed at this plant December 26, 1923. This ore, amounting to 3,726 tons, averaged 1.555 per cent of copper. The concentrates from this new mill will be smelted at the Calumet & Arizona smelter, at Douglas.

Amole district.—Four producers in the Amole district reported 64 tons of ore, containing gold, silver, and copper valued at $1,084. The Old Mission & Arizona property was the principal producer of gold-silver ore taken out in an effort to develop milling ore. The Mission group of claims is said to have 16,000 tons of ore in sight that will average $4 in gold and 8 ounces of silver to the ton. The ores from the Arizona group carry about 10 per cent of lead with a little gold and silver and are hauled 5 miles northeast to Tucson.

Arivaca district.—The output of the Arivaca district consisted of two lots of gold ore treated by amalgamation and one small lot of lead ore shipped to the smelter.

Baboquivari district.—One lot of silver ore containing copper was shipped from the Silver Basin property. The ore carries about 125 ounces of silver to the ton and was hauled 60 miles to Tucson.

Cerro Colorado district.—Lessees on the Cerro Colorado mine shipped to the smelter ore containing from 8 to 217 ounces of silver to the ton and from 1 to 5.5 per cent of copper. The total output amounted to more than 200 tons, which was hauled to Amado, on the Southern Pacific Railroad.

Cobabi district (*Comobabi*).—The principal producer in the Cobabi district was the Little Mary mine, from which hand-sorted oxidized copper-lead ore containing gold and silver was shipped. The ore was hauled 72 miles by autotruck to the railroad. The largest lot assayed 0.33 ounce of gold and 37.6 ounces of silver to the ton, 37.5 per cent of lead, and 8.83 per cent of copper. The mine is opened by an inclined shaft 120 feet deep with 150 feet of drifts and a winze 44 feet deep.

Coyote district.—Oxidized copper ore of smelting grade, containing a little silver and gold, was taken out during the development of the Bonanza mining claims. The property is in the Coyote Mountains, 38 miles west of Tucson, and the ore deposit forms lenses in limestone.

Empire district.—Four producers in the Empire district reported 665 tons of ore and old tailing of shipping grade, which contained $691 in gold, 4,952 ounces of silver, 5,209 pounds of copper, and 177,057 pounds of lead, valued in all at $17,912. Most of the output was from the Forty-nine property, which produced oxidized ore assaying from 4 to 17 ounces of silver to the ton and from 13 to 38 per cent of lead. From the Jerome, Red Cloud, and State of Maine claims about a carload of oxidized lead ore, carrying silver and a little gold, was shipped to the smelter at El Paso, Tex. To the same smelter several lots of mill tailing were shipped from the Total Wreck property containing nearly 8 ounces of silver to the ton, 8.7 to 10.7 per cent of lead, and 1.23 to 1.75 per cent of copper. The shipping points for ore from the Empire district are Pantano and

Vail, on the Southern Pacific Railroad, requiring a haul of about 10 to 12 miles.

Helvetia district.—Eight shippers of ore in the Helvetia district reported the production of 683 tons of ore, containing $163 in gold, 5,024 ounces of silver, 69,633 pounds of copper, and 40,590 pounds of lead, valued in all at $17,360. The principal ore shipments were made from the Peach, Mohawk, and King claims of the Rosemont property by lessees and consisted of copper ore containing gold and silver. Included in the output was one lot of lead ore. The Feather, Fairview, Frijoli, and Dimple claims produced oxidized silver-lead ore of smelting grade. Ore from the district is hauled either 15 miles west to Sahuarita station or 9 miles north to Vail, on the Southern Pacific Railroad.

Pima district (Olive, San Xavier, Twin Buttes).—Five mine operators in the Pima district shipped 17,545 tons of ore of smelting grade, containing $39 in gold, 32,491 ounces of silver, 2,175,425 pounds of copper, and 9,420 pounds of lead, valued in all at $347,129. The Copper Queen property of the Midland Copper Co. was the largest shipper of ore. Repair work and unwatering the 700-foot inclined shaft began in August, 1922, and extended to March 1, 1923, after which production from the property was continuous. About 200 feet of shaft work was done in 1923. The ore, which is sulphide, occurs in a contact deposit replacing garnetized limestone, but the lenses are irregular and pockety. The company operates its own railroad, 9 miles long, which connects the mine with the Southern Pacific Railroad. In 1923 the company reported paying $30,000 in dividends. Other properties producing were the Paymaster and Vulcan mines.

Quijotoa district.—From the Ballas silver-lead property, about 4 miles northwest of Quijotoa, two lots of ore averaging 192 ounces of silver to the ton, 22 per cent of lead, and 1.85 per cent of copper were shipped to the smelter.

Silver Bell district.—Most of the ore produced in the Silver Bell district was copper ore from the El Tiro property, which was shipped to smelters. Work at the Atlas mine was discontinued in May, after two months' activity, during which copper ore was shipped. Several lots of silver-lead ore containing a little copper were shipped from the Carbonate group, owned by the Indiana Arizona Copper Co. The Imperial mine produced several lots of copper sulphide ore, which was shipped to the smelters at El Paso and Hayden.

PINAL COUNTY

The production in Pinal County showed large increases in every item—the ore from 1,198,313 to 2,784,011 tons, gold from $11,218 to $75,400, silver from 62,841 to 354,398 fine ounces, copper from 28,037,446 to 68,592,790 pounds, lead from 24,902 to 75,506 pounds, and total value from $3,860,484 to $10,454,431. The number of producers was 38, a gain of 5. Most of the ore came from the mines at Ray. Nearly all of it, or 2,759,417 tons, was of concentrating grade and produced 210,902 tons of copper concentrates. The ores of smelting grade aggregated 24,497 tons. A small amount of placer bullion was reported by one operator.

Bunker Hill district (*Copper Creek*).—The output of 223 tons of ore produced by 8 operators in the Bunker Hill district contained $182 in gold, 17,056 ounces of silver, 37,818 pounds of copper, and 61,179 pounds of lead, valued in all at $24,009. All the ore was of shipping grade, and most of it was copper ore from the Fortuna property. The Bunker Hill Copper Co. shipped several lots of sulphide lead ore and copper ore to the smelter. The lead ore carried as high as 45 per cent of lead, 16 ounces of silver, and $2 in gold to the ton. The copper ore contained 11.67 per cent of copper and 18 ounces of silver and $3.80 in gold to the ton. The Bunker Hill mine is developed by a vertical shaft 312 feet deep and 618 feet of drifts. The Copper Sulphide claim produced copper-lead ore, which contained 23 per cent of lead, 4.5 per cent of copper, and 45.3 ounces of silver to the ton. Sulphide copper-lead ore was shipped from the Thornwood claim, and sulphide copper ore was produced from the Figueroa, Felicada, Rough Rider, and Battle Axe claims. The ore of shipping grade is hauled 33 miles to Winkelman.

Casa Grande district.—A small lot of silver-lead ore was produced from the Orizaba claim, which is 22 miles south of Casa Grande, the loading station on the Southern Pacific Railroad.

Cottonwood district.—The Silver Queen property, 9 miles south of Winkelman, produced several lots of first-class silver ore.

Goldfields district.—Lessees worked the property of the Goldfield Mining & Milling Co. and treated ore in the 5-ton Gibson amalgamation mill. Gold bullion containing a little silver was shipped to the mint at San Francisco, Calif.

Mammoth district.—Ore containing copper was shipped from the old dumps of the Copper Giant property, which has not been worked since 1910.

Mineral Creek district (*Ray, Kelvin*).—Three producers in the Mineral Creek district reported 2,702,010 tons of ore in 1923, compared with 1,196,809 tons in 1922. Other than a small lot of lead ore and one lot of silver ore containing copper, the output came from the Ray Consolidated property and was treated in the concentration mill at Hayden. With a daily output of 7,399 tons of ore the Ray Consolidated mine [18] produced 2,688,598 tons of concentrating ore, averaging 1.57 per cent of copper, and 12,191 tons of ore, averaging 1.76 per cent of copper, used at the smelter for fluxing. Altogether 2,700,789 tons of ore, averaging 1.57 per cent of copper, was shipped to Hayden. The mining cost was $1.09 a ton, compared with 99 cents in 1922. These costs do not include depreciation nor the usual charge of 15 cents a ton to cover the expense of extinguishment of mine development. Of the total cost coarse crushing and loading amounted to 5 cents a ton, leaving the net mining cost $1.04. The total ore milled was 2,689,800 dry tons, making a total since the beginning of operations of 27,796,450 tons, averaging 1.67 per cent of copper. The average recovery was 74.87 per cent of the entire copper content, equivalent to 23.52 pounds of copper to the ton, as compared with 76.66 per cent, or 24.34 pounds, in 1922. The concentrate recovered amounted to 187,286 dry tons, averaging 16.89 per cent of copper. The recovery of copper occur-

[18] Ray Consolidated Copper Co. Fifteenth Ann. Rept., for 1923.

ring in the form of sulphides averaged 83.18 per cent, and the recovery of the carbonates and other oxidized copper minerals, which are not readily amenable to water concentration, was 30.87 per cent. The milling cost, excluding charge for depreciation, for which there was no cash outlay, was 64 cents a ton, compared with 83 cents in 1922. The company's annual report continues as follows:

The gross production from all sources, as compared with the three previous years, was as follows:

	1923	1922	1921	1920
Copper in concentrates.....pounds..	63,275,229	28,682,158	10,407,840	48,147,361
Copper from direct smelting ore.....do....	428,920	432,419	144,339	492,081
Total production from all sources..do....	63,704,149	29,114,577	10,552,179	48,639,442

The net production for the year from all sources, after allowing for smelter deductions, was 61,385,205 pounds, as compared with 27,953,408 pounds and 10,110,131 pounds for the years 1922 and 1921, respectively, and to 88,582,649 pounds for the year 1917, when operating at practically normal capacity.

The average cost per net pound of copper produced from mill and from direct smelting ore for the year was 12.03 cents, as compared with a cost of 12.41 cents for the previous year. This cost takes into account credits for the value of gold and silver and miscellaneous income. The costs stated include the usual charge to cover extinguishment of mine development expenditures, which amounts to 15 cents per ton of ore, and all operating and fixed and general expenses of every nature, except depreciation of plant and equipment.

Old Hat district.—The Apache claim, situated at Canada del Oro, 8 miles southeast of Oracle, produced a small lot of ore containing silver and copper, and the Apollo prospect, at Schultz, 3 miles from Mammoth, yielded gold ore valued at $46 a ton. From the New Year mine, at Schultz, a small lot of copper ore and lead vanadate concentrates were shipped, probably from former operations. Several small lots of gold were purchased from placer operations. The fineness of the product was 0.824 in gold and 0.169 in silver.

Owl Head district.—Four producers in the Owl Head district reported the shipment of 41 tons of ore, containing $442 in gold, 3,409 ounces of silver, and 620 pounds of copper, valued in all at $3,328. One lot of ore containing 120 ounces of silver to the ton was reported from the Vaquero, Star, and Cintas de Plata claims, 14 miles north of Postvale. A small lot of shipping ore from the Golden Eagle claim carried 3.24 ounces of gold and 26 ounces of silver to the ton. The ore from the district is hauled 15 miles west to Red Rock, on the Southern Pacific Railroad.

Picacho district.—The Detroit group of claims, 7 miles west of Red Rock, on the Southern Pacific Railroad, produced copper ore containing silver.

Pioneer district (Superior).—Eight mine operators in the Pioneer district reported an output of 79,276 tons of ore, containing principally copper, silver, and gold, with a total value of $1,274,790. The Magma copper mine was the largest producer of copper ore, part of which, with some concentrate, was shipped to a custom smelter and the remainder held in reserve for the new smelting plant under construction during 1923. The capacity of the flotation-concentration mill was doubled to treat 600 tons of ore a day. The

development work amounted to 2,549 feet of drifts, 2,896 feet of raises, 633 feet of shaft sinking, and 1,592 feet of crosscuts. From the Magma mine[19] 78,889 dry tons of ore was shipped averaging 5.27 per cent of copper and 2.87 ounces of silver and 0.033 ounce of gold to the ton. Of this output 9,272 tons, assaying 15.99 per cent of copper and 5.79 ounces of silver and 0.073 ounce of gold to the ton, was of smelting grade. The milling ore, of which 69,617 tons was concentrated, assayed 3.84 per cent of copper and 2.48 ounces of silver and 0.029 ounce of gold to the ton. From this ore, milled at Superior, 24,519 tons of concentrate was recovered, assaying 10.07 per cent of copper and 6.59 ounces of silver and 0.082 ounce of gold to the ton. Nearly all of these concentrates (23,617 tons) and ore of smelting grade (8,464 tons) were treated at the smelter of the American Smelting & Refining Co. at Hayden. Shipments to the Hayden plant were stopped December 25, 1923, and after that date the ore was stocked at Superior, where the new smelter of the Magma Copper Co. is under construction. Operations at this new plant began in March, 1924. The Magma mine is opened to a depth of 2,500 feet by shaft No. 2. Shaft No. 3, which is 2,082 feet deep, is to be continued to the 2,500-foot level. The company's report says:

> During the past year underground exploration work was confined to a number of crosscut diamond-drill holes drilled into the vein from the east footwall drift on the 2,000-foot level, and one or two holes drilled from the face of the east drift on the 1,600-foot level. Approximately 1,500 feet east of the main crosscut or the eastern limits of the main ore body several holes gave encouraging results. One hole shows 6 feet of ore assaying 4.76 per cent of copper, 1.87 ounces of silver, and 0.01 ounce of gold, and another hole shows 5 feet of ore assaying 13.5 per cent of copper, 11.46 ounces of silver, and 0.026 ounce of gold. Directly above these two holes on the 1,600-foot level a diamond-drill hole shows 4 feet of ore assaying 3.06 per cent of copper, 5.8 ounces of silver, and 0.01 ounce of gold. * * *
>
> On starting up the concentrator (remodeled to 600 tons of ore daily) we found that sufficient copper and iron sulphates had formed on the ore underground during the shutdown period to considerably interfere with flotation. During the month of April the tails averaged 0.813 per cent of copper with a total copper extraction of 86.89 per cent. During the balance of the year, as the soluble sulphates decreased the recoveries improved, so that in December the total copper content of the tails was 0.296 per cent and the recovery 94.49 per cent.
>
> The broad-gage railroad was completed during the year and was utilized for handling most of the construction material in the smelting plant of the Magma Copper Co and also handled all of the crude ore and concentrates which were shipped by the Magma Copper Co. to the Hayden smelter.

Included in the output of the Pioneer district is the ore shipped from one of the dumps of the Silver Bell Consolidated Mining Co.'s property, about 9 miles northeast of Price, a station on the Arizona Eastern Railroad. No ore was mined, but the dump ore, of which several carloads were shipped, contained an average of about 16 ounces of silver to the ton and 5 per cent of lead. A small lot of ore containing 17.5 per cent of copper and 1.15 ounces of silver to the ton was shipped from the White Elephant property.

Priorwood district.—A small lot of ore containing 21 ounces of silver to the ton and a little copper was shipped from the Ruby Silver claim to the smelter at Hayden.

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[19] Magma Copper Co. Ann. Rept. for 1923.

Saddle Mountain district.—The old Odell group, operated by the Adjust Mining Co., produced 1,860 tons of ore, containing 130.7 ounces of gold, 52,405 ounces of silver, and a little copper. Smaller lots of ore were shipped from the Jack Lee, Two Queens, and Lawrence properties. These mines are 4 to 6 miles from Christmas station, on the Arizona Eastern Railroad.

Summit district.—A small lot of copper ore was taken from the Fuhrman claim and hauled 11 miles to the smelter at Miami. The ore assayed 2.48 ounces of silver and 0.005 ounce of gold to the ton and contained 29.93 per cent of copper, 26 per cent of silica, 15 per cent of iron, and 22 per cent of sulphur.

SANTA CRUZ COUNTY

Twenty-nine producers in Santa Cruz County reported an output of 6,738 tons of ore, or 3,245 tons more than was reported by the same number of producers in 1922. Ore of shipping grade amounted to 5,468 tons, valued at $176,277. At milling plants 160 tons of ore yielded gold and silver bullion having a total value of $1,462.

Harshaw district.—The Flux mine produced crude lead ore, which, with considerable old tailing from former mill operations, was shipped to a lead smelter. About 600 tons of silver ore, containing a little copper and gold, was shipped from the American mine to a copper smelter at Douglas. The ore shipped carried from 19 to 30 ounces of silver to the ton and was hauled 11 miles north to the loading station at Patagonia. Silver ore containing a little copper, mined from the Black Eagle mine, was shipped to Douglas. Other producers, chiefly of lead ore, were the World's Fair, Hardshell, and Trench mines.

Oro Blanco district.—A little silver bullion containing gold was shipped from previous operations of the Progressive group of claims. Neither mine nor mill was operated during 1923.

Palmetto district.—The Hollywood and Bob Lee claims were operated by the Taft Mining & Exploration Co., which is said to have produced a little ore, containing 64 per cent of lead and 54 ounces of silver to the ton. The property is 13 miles from Nogales.

Patagonia district (Washington, Duquesne).—Ten mine operators in the Patagonia district reported the output of 3,400 tons of ore, all of which, with the exception of 10 tons milled, was of shipping grade. Considerable lead and copper ore containing silver, produced from the Duquesne mine by lessees, was hauled 8 miles south of the mine to Zorilla, Sonora, Mexico, the loading station on the Southern Pacific Railroad, for shipment through the port of Naco to El Paso and Douglas. Copper ore was also produced from the Santo Niño mine for shipment to Douglas by way of Zorilla. The Morning Glory mine was operated 10 months in 1923, producing copper ore which was hauled 13½ miles north to Patagonia and shipped by rail to Douglas. Similar ore was shipped from the Thessalia property.

Red Rock district.—Four tons of ore was shipped to the smelter from the Frisco Fair claim, 18 miles east of Patagonia. The ore contained about 20 ounces of silver to the ton and 19 per cent of lead.

Tyndall district (Alto).—The Tyndall district has the largest mineralized area in Santa Cruz County. Considerable ore was

shipped from the Bacca Float grant, which embraces the Jefferson mine, 2 miles north of Salero. A number of lessees who operated on the property in 1923 mined ore containing principally silver and lead with some copper and a little gold. Shipments of lead ore were reported from the Bonanza, Apache, and other claims operated by lessees.

Wrightson district.—Silver ore from the Ivanhoe group was shipped to the smelter in May, and lead-silver ore was produced from the Dixie and Blue Lead properties.

YAVAPAI COUNTY

Although the number of producers in Yavapai County decreased from 83 to 73, the production showed increases in every item—ore from 601,389 to 1,594,268 tons, gold from $464,101 to $1,902,378, silver from 949,331 to 2,879,763 fine ounces, copper from 76,607,502 to 147,718,492 pounds, lead from 82,199 to 226,953 pounds, and total value from $11,759,966 to $25,994,289.

No zinc was reported in 1923. Most of the first-class ore shipped to smelters consisted of copper ore—1,211,664 tons, all of which was sulphide. The average value of the smelting ore was $16.86 a ton. Concentrates amounting to 17,919 tons, derived from 84,215 tons of ore, were valued at $771,302. The placer output was $4,485 in gold and 38 ounces of silver, against $5,777 in gold and 58 ounces of silver in 1922.

Agua Fria district.—Operations at the Arizona Binghampton property resulted in the production of considerable ore, which was milled in the company's flotation plant. More than 8,000 tons of siliceous ore was mined from the Iron King mine. This ore carried principally silver, with a little copper and gold, and part of it was concentrated, but most of it was shipped directly to smelters.

Big Bug district.—Twelve producers in the Big Bug district reported 85,062 tons of ore, which with the output of small placer operations made up the production of $57,834 in gold, 148,238 ounces of silver, 4,874,836 pounds of copper, and 207,357 pounds of lead, valued in all at $910,505. The average value of the ore was $10.70 a ton. Smelting ore amounted to 31,223 tons and contained 1,816.98 ounces of gold, 63,703 ounces of silver, 2,838,747 pounds of copper, and 53,980 pounds of lead. The ore concentrated amounted to 53,839 tons and produced 12,817 tons of concentrates, which contained 959.73 ounces of gold, 84,532 ounces of silver, 2,036,089 pounds of copper, and 153,377 pounds of lead. The ore and concentrates containing lead were shipped to the smelter at El Paso, Tex., and copper ores were treated at Humboldt. Most of the ore produced, containing copper, silver, and gold, came from the Blue Bell mine, operated by the Southwest Metals Co. From the Arizona National property, leased by the Atlas Mining Co., considerable ore was mined and lead concentrate containing silver was shipped to El Paso, Tex. This mine is developed by an inclined shaft 155 feet deep, with an inclined winze 280 feet deep. The ore is mostly sulphide with a siliceous gangue, and reserves for future operations are said to amount to about 2,500 tons, carrying 20 ounces of silver to the ton and 3 per cent of lead. The 60-ton flotation and concentration mill

on the property was operated nearly the entire year. Lead ore was produced from the Pocahontas property, and copper ore carrying gold and silver was produced from the Great Belcher and Huron Copper properties. Other producers were the Wymazona and Dividend mines. In the vicinity of Mayer a little placer mining resulted in the production of placer bullion, which had a fineness of 0.924 in gold and 0.069 in silver.

Black Canyon district.—Four producers in the Black Canyon district reported the output of 71 tons of ore, containing $879 in gold, 937 ounces of silver, and 2,936 pounds of copper, valued in all at $2,079. The Golden Belt claim produced a little gold ore, which was shipped to the smelter at Hayden, and similar ore was shipped from the Turkey property. A little silver ore was also produced from the Good Luck claim.

Black Hills district.—The Red Bird mine produced gold ore carrying a little silver and copper, which was shipped to the Humboldt smelter. At the Yaeger Canyon property a lessee sorted and shipped about 2 tons of 26 per cent copper ore from the mine dump.

Castle Creek district.—Ore was milled in the flotation plant on the Abe Lincoln property, operated by the Lincoln Operating Co., and copper concentrate was hauled 16 miles to Wickenburg. Considerable ore was also mined from the Robey mine by the Arizona Leasing Syndicate, which treated ore by amalgamation and concentration and shipped bullion and concentrate containing gold and silver. Ore from the Little Wallie and Rattlesnake claims, in Copperopolis Gulch, was amalgamated in a local mill and some gold bullion produced.

Cherry Creek district.—Ore from the Wheatley claims was treated in the Federal mill, and a little bullion was produced by amalgamation.

Copper Basin district.—The Senator property was operated by the Phelps Dodge Corporation, and ore containing copper, silver, and a little gold was shipped to the smelter at Hayden.

Eureka district.—First-class lead ore containing considerable gold and some silver was shipped to the smelter from the Hillside property.

Hassayampa district.—The Sunset property, on Groom Creek, and two other claims produced gold and silver ore amounting to 75 tons, valued at $2,149. This ore was shipped to the smelter at Humboldt. A little placer bullion was produced which had a fineness of 0.876 in gold and 0.118 in silver.

Martinez district.—Lessees at the Congress mine worked rich but narrow veins and shipped gold ore to the smelter.

Peck district (Ocotillo).—The Swastika mines and the Brestlin group of claims, or the northern extension of the Swastika, produced considerable silver ore, which contained a total of 44,497 ounces of silver. This ore, with two carloads of similar ore from the Peck mine, was shipped to the smelter at Humboldt. The total output of 5 producers was 561 tons of ore, valued at $40,499.

Pine Grove district.—Seven mine operators in the Pine Grove district each reported small lots of ore, the total amounting to 67 tons, containing gold, silver, and copper, valued at $2,960. Nearly all the ore produced was siliceous and was shipped to the smelter at Humboldt. A small quantity of gold bullion was recovered in cleaning up amalgamation plants.

Silver Mountain district.—The Comet claim produced gold ore, which was treated in an arrastre. At the Horse Shoe placer, on French Creek, a hand rocker was used in recovering a small lot of bullion having a fineness of 0.841 in gold and 0.152 in silver.

Thumb Butte district.—A small lot of high-grade silver ore was shipped from the Mistake group.

Tiger district (*Crown King, Harrington*).—One lot of silver ore was shipped from the Cougar claims.

Tip Top district.—The Kay Copper property, at Canon, 40 miles north of Phoenix, is opened by an inclined shaft (No. 1) 600 feet deep, a second shaft (No. 3) 530 feet deep, and a vertical shaft (No. 4) 800 feet deep. These developments, with 7,640 feet of crosscuts and drifts and 3,188 feet of diamond-drill holes, are reported [20] to have opened an ore reserve of 70,793 tons, averaging 5.06 per cent of copper and $2.34 in gold and silver to the ton; also 103,476 tons of probable ore, averaging 3.60 per cent of copper and $2 in gold and silver to the ton.

Turkey district.—Three producers in the Turkey district reported the output of 470 tons of ore, containing $3,573 in gold, 2,985 ounces of silver, and 35,249 pounds of copper, valued in all at $11,203. Copper ore from the French Lily mine formed the principal part of the output. A small lot of silver ore was shipped from the Buckeye property. All the output was sent to the smelters at Humboldt and Hayden.

Verde district (*Jerome*).—Four producers in the Verde district reported the output of 1,465,006 tons of ore, all of which, with the exception of 23,861 tons milled, was directly smelted. The total output of the district contained $1,745,004 in gold, 2,480,692 ounces of silver, and 140,425,401 pounds of copper, valued in all at $24,421,705. The United Verde and United Verde Extension properties were the chief producers of copper ore. One lot of silver ore containing a little copper was shipped from the Shea mine, and considerable crude ore from the Copper Chief mine was treated by cyanidation. The Copper Chief ore deposit is completely oxidized from the surface to a depth of 226 feet. The mine is opened by an 840-foot adit. The ore body, according to Weed,[21] is a boat-shaped mass, which runs across three of the claims, is 60 to 95 feet wide, and consists of copper-bearing iron oxide carrying gold, silver, and a little copper, the total value being from $8 to $13 a ton. The bottom of the ore lens consists of massive pyrite with about 5 feet of enriched ore between the sulphide and the overlying oxidized material. The owners of the Copper Chief mine report having about 24,000 tons of old tailing assaying 0.034 ounce of gold and 3.84 ounces of silver to the ton.

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[20] Kay Copper Corporation, printed statement of organization, Jan. 24, 1923.
[21] Mines Handbook, vol. 15, p. 255, 1922.

About 11 miles from Clarkdale, at no great distance from the Copper Chief mine, is the Monarch mine, an old gold producer, which, with the Sunshine group of claims, was operated by the Verde Mines & Milling Co. The new mill on this property has 10 stamps and plates for amalgamation and 2 vanners. It was run in 1923 on ore for a day or so and produced about $400 in gold bullion, which was not sold. The older 5-stamp mill, which worked the richer gold ore of the Monarch mine, is a part of the new mill and is equipped with a 30-ton plant for cyanidation of the tailing. Water is supplied from springs for mill and domestic use by a 5,500-foot pipe line owned by the company. The mine is opened by a vertical shaft 210 feet deep, an adit 1,600 feet long, and 800 feet of drifts. More than 450 feet of this work was done in 1923. The ore reserve reported by the company is estimated at 43,000 tons, containing from $10 to $30 a ton in gold, of which an average mill test gave $12.50 a ton.

The United Verde Copper Co. produced about 8,000,000 pounds of copper a month, a rate to which it was limited by the quantity of ore that could be crushed for delivery to the smelter. Construction of a new crushing plant[22] was started in 1921 and completed in December, 1923. At the same time the old Hopewall crushing plant, built in 1915 at the mine-tunnel portal, was remodeled. With these new crushing facilities in operation and other surface equipment improved, the underground production of 3,000 tons to a possible 4,500 tons a day will be easily handled. The steam-shovel operations promised a maximum of 2,000 tons of ore a day in 1924. According to the superintendent of the United Verde mine,[23] the actual and probable ore is estimated at 11,000,000 tons, including 5,000,000 tons of ore in the shovel and fire areas, with a probable average content of 48 pounds of copper to the ton of ore. From 1888 to the end of 1922 the mine has produced, according to Superintendent Smith, 1,111,971,696 pounds of copper, 563,375 ounces of gold, and 18,406,232 ounces of silver. The cost of making a pound of copper from United Verde ore is distributed as follows: Labor, 3.67 cents; fuel and power, 2.03 cents; supplies, 2.64 cents; freight on bullion, 0.7 cent; refining, 1.15 cents; taxes, 1.98 cents; and depreciation, 0.5 cent.

The United Verde Extension Mining Co.,[24] believing that the advance in the price of copper in March and April to more than 17 cents was only temporary, increased its output to a total of 41,855,959 pounds of copper, 257,602 ounces of silver, and 8,992 ounces of gold, recovered from the smelting of 172,629 dry tons of ore. Development in the United Verde Extension and Jerome Verde ground was continued to the 1,700-foot level, where the appearances toward the southeast in the Jerome Verde ground were particularly encouraging. Ore reserves so far developed by the company are above the 1,600-foot level and are estimated at 940,786 tons, averaging 9.97 per cent of copper and 2.05 ounces of silver and 0.031 ounce of gold to the ton. The cost of mining was 2.72 cents a pound of copper

[22] Described fully in Arizona Min. Jour., Phoenix, Dec. 15, 1923.
[23] Smith, De Witt, lecture before employees of the United Verde Copper Co.: Arizona Min. Jour., Phoenix, Mar. 1, 1923.
[24] United Verde Extension Mining Co. Ann. Rept. for 1923.

produced; smelting, 2.31 cents; freight on ore, 0.08 cent; freight on bullion, refining, and selling, 2.08 cents; and other expenses, 0.08 cent—a total of 7.27 cents a pound. Dividends paid to stockholders amounted to $3,675,000.

At the Verde Central mines[25] development was discontinued in the No. 3 and No. 4 tunnel adits, owing to the discovery of greater mineralization of the greenstone on the 800-foot level, which led to sinking the shaft to the 1,000-foot level. A drift run southward along the contact for more than 800 feet demonstrated the extent of mineralization and revealed larger areas of black schist, nearly all of which carried disseminated chalcopyrite.

Walker district (*Lynx Creek*).—The output of ore from five operators in the Walker district was 9,155 tons, and the bullion from the operations of five placer producers amounted to $2,356. Most of the ore was milled and amounted to 5,044 tons, which yielded 1,284 tons of concentrates, containing 1,212.21 ounces of gold, 38,014 ounces of silver, 239,087 pounds of copper, and 10,341 pounds of lead. The ore of shipping grade amounted to 3,905 tons, containing 1,114.49 ounces of gold, 39,121 ounces of silver, 199,211 pounds of copper, and 3,179 pounds of lead. Gold and silver bullion was recovered from 206 tons of milling ore. The Sheldon property was the largest producer of concentrating ore and crude copper ore containing silver and gold, which was shipped directly to the reduction works at Humboldt. The mine is opened by a shaft 650 feet deep and has about 4,000 feet of drifts and crosscuts. The Blue John property was worked intermittently, and ore was treated in the amalgamation and concentration mill on the property, yielding gold bullion and lead-silver concentrates. Lead ore was shipped to the smelter from the Express mine, and a small lot of ore of milling grade from the Farnum property produced gold bullion and concentrate at the Blue John mill. More placer gold is annually credited to this district than to any other district in the county. The gold is sent in small lots to the merchants and bankers in the vicinity or shipped directly to the mint at San Francisco. The gold from the different tributaries of the main gulches varies in fineness.

Walnut Grove district.—Several small lots of placer gold were shipped to the mint at San Francisco from the Walnut Grove district and vicinity. Some of the gold had a fineness of 0.905.

Weaver district (*Octave*).—The St. Elmo and Red Metal claims were operated, and some concentrate containing gold was produced in the 10-stamp amalgamation and concentration plant on the property. In recent years the output of placer gold has been small, but placers are constantly operated by miners who sell the product to local merchants. One operator reported that he averaged about 50 cents a day in gold during 1923. The placer product shipped from the district had a fineness of 0.918 in gold and 0.077 in silver, and most of it was sold to the mint at San Francisco or to travelers for pocket pieces.

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[25] Calumet & Arizona Mining Co. Ann. Rept. for 1923.

YUMA COUNTY

The total value of the gold, silver, copper, and lead produced in Yuma County was $989,996, against $514,048 in 1922. The placer production was valued at $1,132.

Castle Dome district.—The Lady Edith and Sonora claims produced lead-silver ore, which was hand sorted and jigged for shipment to a smelter near San Francisco.

Cienega district.—Lessees shipped a small lot of copper ore containing gold from the Carnation property.

Ellsworth district.—Six producers of ore in the Ellsworth district reported the production of 169 tons, all of which, with the exception of 32 tons that was milled, was shipped to the smelter at Hayden. The total ore output of the district contained $1,192 in gold, 2,354 ounces of silver, and 32,344 pounds of copper, valued in all at $7,877. Most of the milling ore was amalgamated, and gold bullion was produced. Ore of shipping grade came from the Apache Chief, Desert, and Congress No. 1 lode, and the ore milled from the operations of lessees on several prospects.

Planet district (*Swansea*).—The Swansea lease on the Signal property continued to be active, and considerable ore was produced. The greater part of the ore was milled on the property, and the remainder, with the concentrates, was shipped to the smelter at Humboldt. The mine is opened by a vertical shaft 750 feet deep and has about 1,500 feet of drifts and crosscuts. A 400-ton concentration mill is equipped for flotation only.

Plomosa district.—The Dutchman property, 5 miles west of Bouse, was worked, and a small quantity of gold ore was treated in an experimental mill equipped for amalgamation. Near Quartzsite a little placer gold was recovered by dry methods. The resulting bullion had a fineness of more than 0.900 in gold and was sold to merchants in the vicinity or shipped directly to the mint at San Francisco.

GOLD AND SILVER

(GENERAL REPORT)

By J. P. Dunlop

PRODUCTION

DOMESTIC PRODUCTION

Approximate distribution, by producing States and Territories, of the production of gold and silver in the United States in 1923

[Figures supplied by the U. S. Bureau of the Mint]

State or Territory	Gold		Silver	
	Fine ounces	Value [a]	Fine ounces	Value [b]
Alaska	314, 960	$6, 510, 800	816, 177	$669, 265
Arizona	296, 437	6, 127, 900	7, 376, 832	6, 049, 002
California	651, 369	13, 465, 000	3, 689, 856	3, 025, 682
Colorado	315, 686	6, 525, 800	5, 529, 121	4, 533, 879
Georgia	34	700		
Idaho	35, 764	739, 300	8, 019, 977	6, 576, 381
Illinois			10, 175	8, 343
Michigan			253, 705	208, 038
Missouri			167, 452	137, 311
Montana	85, 145	1, 760, 100	14, 226, 272	11, 665, 543
Nevada	198, 415	4, 101, 600	10, 640, 656	8, 725, 338
New Mexico	23, 728	490, 500	737, 863	605, 048
North Carolina	53	1, 100	79	65
Oregon	23, 631	488, 500	75, 583	61, 978
Pennsylvania	131	2, 700	1, 278	1, 048
Philippine Islands	76, 137	1, 573, 900	39, 360	32, 275
Porto Rico	5	100	184	151
South Carolina	14	300		
South Dakota	307, 012	6, 346, 500	95, 822	78, 574
Tennessee	319	6, 600	109, 086	89, 450
Texas	44	900	825, 267	676, 719
Utah	156, 991	3, 245, 300	20, 479, 550	16, 793, 231
Washington	16, 733	345, 900	240, 712	197, 384
Wyoming	24	500	163	134
	2, 502, 632	51, 734, 000	73, 335, 170	60, 134, 839

[a] Gold valued at $20.67+ a fine ounce.

[b] Silver valued at 82 cents an ounce—the average of the Pittman Act price ($1 an ounce) January to June and of the New York price July to December.

The figures in this table were obtained through cooperation between the United States Bureau of the Mint and the United States Geological Survey and were agreed upon after conference and adjustment between the two bureaus. They are therefore final for both.

The totals are based on bullion deposits in the United States mints and assay offices and on returns to the Bureau of the Mint from the smelting and refining companies. The distribution is adjusted by means of information collected by the United States Geological Sur-

vey directly from the producing mines and tabulated for the mine reports later discussed. The data for the total production and in part for the distribution are obtained from records of (1) the unrefined domestic gold and silver deposited in United States mints and assay offices, (2) the domestic gold and silver in fine bars reported by private refineries, and (3) the unrefined domestic gold and silver contained in ore and matte exported for reduction. The last item is small.

Increase or decrease in production of gold and silver in the United States in 1923

State or Territory	Gold		Silver	
	Fine ounces	Value	Fine ounces	Value
Alaska	−30,670	−$634,000	+45,945	−$100,967
Arizona	+126,733	+2,619,800	+2,749,094	+1,421,264
California	−60,788	−1,256,600	+594,376	−69,798
Colorado	−8,770	−181,300	−489,660	−1,484,902
Georgia	−106	−2,200	−394	−394
Idaho	+12,873	+266,100	+2,228,564	+784,968
Illinois			+5,563	+3,731
Michigan			−107,106	−152,773
Missouri			+48,797	+18,656
Montana	+11,702	+241,900	+4,543,968	+1,983,239
Nevada	+38,371	+793,200	+2,352,952	+437,634
New Mexico	+4,175	+86,300	−26,168	−158,983
North Carolina	−20	−400	+71	+57
Oregon	−97	−2,000	−74,764	−88,369
Pennsylvania	+15	+300	−863	−1,093
Philippine Islands	+2,297	+47,500	+11,366	+4,281
Porto Rico	+5	+100	+184	+151
South Carolina	+9	+200		
South Dakota	−13,390	−276,800	−25,605	−42,853
Tennessee	+101	+2,100	+32,201	+12,565
Texas	+25	+500	+171,610	+23,062
Utah	+49,816	+1,029,800	+5,014,348	+1,328,029
Virginia	−34	−700	−6	−6
Washington	+7,339	+151,700	+21,314	−22,014
Wyoming	−29	−600	−665	−694
	+139,557	+2,884,900	+17,095,122	+3,894,791

Domestic smelters and refiners produced 798,202 fine ounces of gold and 74,448,854 fine ounces of silver from foreign ore and bullion, an increase of 72,921 ounces of gold and of 10,267,927 ounces of silver compared with the corresponding figures for 1922. The foreign ore came mainly from Mexico, Canada, and Peru.

The value of the new gold used in the arts and industries in the United States in 1923 was $40,013,175, compared with $36,321,649 in 1922, and the quantity of new silver used for such purposes was 28,355,171 fine ounces, compared with 31,286,531 ounces. The consumption of new silver in the arts and industries in 1923 was equal to 39 per cent of the domestic production, and that of gold to 77 per cent of the domestic production. In addition to the gold and silver derived from foreign and domestic ore and bullion, $29,279,070 in gold and 8,469,806 fine ounces of silver were recovered from old jewelry, dental waste, silverware, and other old material.

PRICES OF SILVER

The average monthly prices of foreign fine bar silver in New York in 1923 were as follows:

Price of foreign silver per fine ounce in 1923, by months

January	$0.66094	August	$0.63176
February	.64716	September	.64529
March	.67963	October	.63928
April	.67270	November	.64122
May	.67455	December	.65035
June	.65194		
July	.63383	Average	.65239

Silver to be salable to the Director of the Mint under the Pittman Act and mint regulations had to be of undoubted domestic production and reduction, and the benefit of the higher price must have been given to the owner of the producing mine.

The yearly price of silver has trended downward, steadily in the main, from $1.337 and $1.339 in 1865 and 1866 to a low point of $0.507 in 1915. Since that date the trend has been upward. The average yearly price over the period 1865 to 1923 was $0.9117.

Price of domestic silver per fine ounce, 1914–1923 [1]

1914	$0.553	1919	$1.12
1915	.507	1920	1.09
1916	.658	1921	1.00
1917	.824	1922	1.00
1918	.980	1923	.82

PRODUCTION OF GOLD AND SILVER SINCE 1792

Gold and silver produced in the United States, 1792–1923

[The estimate for 1792–1872 is by R. W. Raymond, commissioner, and for the period since 1872 by the Director of the Mint]

Period	Gold		Silver	
	Fine ounces	Value	Fine ounces	Commercial value
1792–1847 [a]	1,186,977	$24,537,000	309,500	$404,500
1848–1872	58,279,781	1,204,750,000	118,568,200	157,749,900
1873–1923	145,813,778	3,014,238,300	2,623,141,555	2,097,107,364
	205,280,536	4,243,525,300	2,742,019,255	2,255,261,764

[a] A careful investigation made by Philip B. Bekeart (Soc. California Pioneers Quarterly, Sept. 30, 1924) appears to have definitely fixed Jan. 19, 1848, as the date of the discovery of gold by James W. Marshall at Sutters Mill, Coloma, Eldorado County, Calif., and to have shown that the first flakes (not a nugget) found by Marshall are now in the National Museum, Washington, D. C.

Although the output of gold during the period 1792–1923 was less than one-thirteenth the output of silver in quantity, its value was nearly twice that of the silver.

The average commercial value per fine ounce of silver for the 131 years contributing to the total domestic production was $0.8225. Fluctuations in value of silver per fine ounce are shown in the curve in Figure 18.

[1] Based on London price of bar silver 1.000 fine and taken at average price and par of exchange, 1914–1915; New York dealers' buying price for 1916–1919; average buying price of silver from domestic mines for 1920–1923.

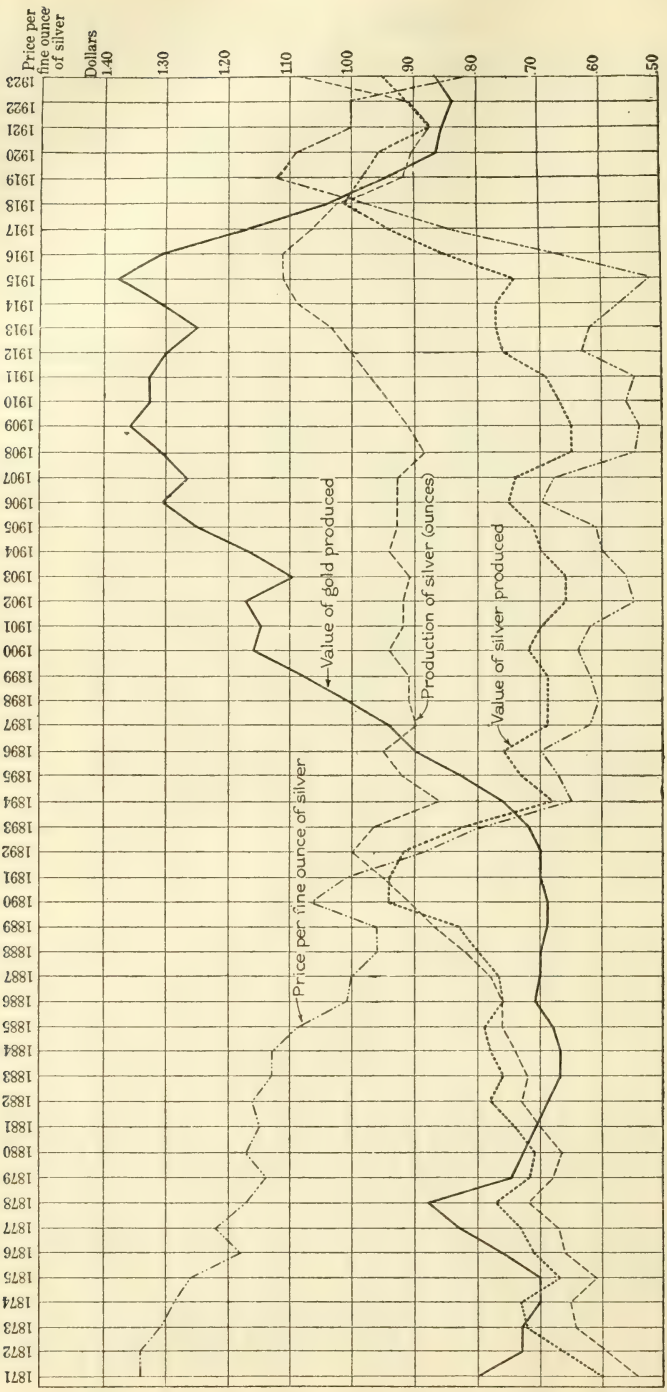


FIGURE 18.—Quantity and value of gold and silver produced and price per fine ounce of silver produced in the United States, 1871–1923

IMPORTS AND EXPORTS

Value of gold and silver imported and exported, 1922 and 1923 [a]

	Imports	Exports	Excess of—	
			Imports	Exports
1922				
Gold:				
Contained in domestic ore and base bullion		$73,709		$73,709
Contained in foreign ore and base bullion	$24,275,253		$24,275,253	
Domestic bullion refined	1,328,408	5,468,225		4,139,817
Foreign bullion refined	180,365,162	81,799	180,283,363	
United States coin	4,868,558	30,323,172		25,454,614
Foreign coin	64,332,404	927,989	63,404,415	
	275,169,785	36,874,894	267,963,031	29,668,140
Excess of imports over exports			238,294,891	
Silver:				
Contained in domestic ore and base bullion		17,237		17,237
Contained in foreign ore and base bullion	57,034,500		57,034,500	
Domestic bullion refined		25,060,886		25,060,886
Foreign bullion refined	11,120,413	31,720,047		20,599,634
United States coin	1,249,247	379,792	869,455	
Foreign coin	1,402,493	5,629,324		4,226,831
	70,806,653	62,807,286	57,903,955	49,904,588
Excess of imports over exports			7,999,367	
1923				
Gold:				
Contained in domestic ore and base bullion		248,771		248,771
Contained in foreign ore and base bullion	24,048,777		24,048,777	
Domestic bullion refined		19,769,016		19,769,016
Foreign bullion refined	186,123,382	66	186,123,316	
United States coin	37,488,237	7,848,658	29,639,579	
Foreign coin	75,055,416	776,906	74,278,510	
	322,715,812	28,643,417	314,090,182	20,017,787
Excess of imports over exports			294,072,395	
Silver:				
Contained in domestic ore and base bullion		45,225		45,225
Contained in foreign ore and base bullion	40,342,858		40,342,858	
Domestic bullion refined		40,127,961		40,127,961
Foreign bullion refined	31,249,574	28,935,369	2,314,205	
United States coin	841,655	214,012	627,643	
Foreign coin	2,019,443	3,146,222		1,126,779
	74,453,530	72,468,789	43,284,706	41,299,965
Excess of imports over exports			1,984,741	

[a] According to Bureau of Foreign and Domestic Commerce, Department of Commerce.

DOMESTIC SUPPLY

The remarkable gain in the domestic supply of gold, indicated by the great excess of $530,000,000 in imports over exports in 1916, of $180,000,000 in 1917 and of $21,000,000 in 1918, had come to a halt in the early part of 1919 but was resumed in 1920, owing to large imports of foreign bullion and coin. This excess continued to grow in 1921 and 1922, and in 1923 it was $294,000,000.

Resumption of mining at base-metal mines increased the quantity of domestic silver, and in June, 1923, according to the Treasury Department, the total purchases reached the quantity of silver necessary under the Pittman Act to replace the silver dollars remelted.

The domestic supply of new gold comes chiefly from dry and siliceous gold ore, treated mainly in gold mills by amalgamation or cyanidation or both and partly by smelting, and from placer gravel worked largely by dredges. As shown on page 572, this ore and the placer

gravel supplied 86 per cent of the yield of gold in 1923, against 92 per cent in 1922. Considerable gold is usually recovered also from the refining of copper bullion from copper ore, especially in the West Mountain or Bingham district, Utah, and the Summit Valley or Butte district, Mont.

In 1923 the copper ore of the United States produced 11.30 per cent of the total gold, against only 2.25 per cent in 1921 and 5.71 per cent in 1922. The natural tendency has been for the proportionate output from gold ore to decrease with declining yield from some of the principal gold camps, and for that from copper ore to increase, with a general net decline of total yield of gold owing to the preponderant output from gold and gold-silver ores.

The principal domestic supply of new silver came from dry and siliceous silver and silver-gold ores, copper ore, lead ore, and lead-zinc ore, in the proportion of 39.28, 20.87, 28.63, and 6.14 per cent, respectively, in 1923, against 46.78, 16.95, 27.38, and 4.96 per cent in 1922. The greater part of the dry and siliceous silver ore is milled and cyanided at or near the mines, but a small quantity of richer ore is shipped to copper and lead smelters.

WORLD'S PRODUCTION OF GOLD

The estimated value of the gold produced in the world from 1860 to 1923, inclusive, was $14,692,392,800. In 1923 the estimated production of the world was $367,732,300, an increase of $48,312,200 over that of 1922. This increase followed a period of successive annual decreases since 1915, when the output was $468,724,918. The production in 1923 in the United States increased $2,884,900, and that of Africa $44,644,500, or about 92 per cent of the total increase in gold. The large increase in the Rand mines in South Africa was due to the absence of labor troubles (which caused the large decrease in 1922) and to the steady working of the mines all the year. There were fair increases in Russia, Peru, Mexico, and Japan.

The prevailing tendency during recent years toward a declining world output of new gold, caused by the high cost of labor and supplies, which made the operation of many gold mines unprofitable, has been modified to some extent by greater political and financial stability in some countries, which will tend to increased operations or the reopening of old properties. This will temporarily result in relatively small increases over the abnormally low output of gold from these countries in the last five or six years. In 1924 there have probably been moderate increases in South Africa, Canada, Mexico, Peru, and a few other countries. In the following table is shown the output of gold by countries, as given by the Bureau of the Mint with slight changes resulting from late information.

World's production of gold, 1918–1923

Country	1918	1919	1920	1921	1922	1923
North America:						
Canada	$14,687,900	$15,850,400	$15,853,500	$19,148,900	$26,116,000	$25,702,100
Central America	3,400,000	3,300,000	3,000,000	2,500,000	2,500,000	2,000,000
Mexico	16,824,700	15,676,500	15,265,900	14,152,600	15,469,200	16,158,400
United States [a]	68,646,700	60,333,400	51,186,900	50,067,300	48,849,100	51,734,000
South America:						
Argentina	4,000	4,000	100,000	75,000	75,000	80,000
Bolivia	5,000	5,000	5,000	6,000	8,400	8,400
Brazil	2,800,000	2,000,000	2,600,000	2,780,000	3,031,900	2,990,700
Chile	765,000	765,000	900,000	933,100	1,650,200	1,331,200
Colombia	4,866,500	6,000,000	5,800,000	6,000,000	5,700,000	5,700,000
Ecuador	800,000	800,000	750,000	749,500	877,600	877,600
Guiana—						
British	400,000	335,200	200,000	265,200	224,800	127,600
Dutch	322,200	329,300	258,500	233,300	247,900	263,200
French	1,100,000	1,100,000	900,000	1,000,000	1,008,200	922,500
Peru	1,250,000	1,348,400	1,297,300	1,599,700	1,683,400	2,488,300
Uruguay	10,000	10,000	400	7,000	7,000	7,000
Venezuela	473,200	600,000	389,400	625,400	358,900	358,900
Europe:						
Austria	[b]180,000			3,300	11,300	15,300
Czechoslovakia		125,600	181,100	235,900	171,400	99,700
France	500,000	151,000		49,100	332,300	350,200
Germany			91,700	86,400	112,300	99,800
Great Britain			700			
Greece		4,600	10,600		8,600	8,600
Italy	22,800	15,300	15,000			25,200
Rumania				856,000	888,500	996,900
Russia and Siberia	12,000,000	11,000,000	1,182,900	892,600	3,032,600	5,181,900
Spain					18,700	18,700
Sweden	10,000	10,000	4,700	1,300	700	
Turkey					29,900	29,900
Yugoslavia			66,500	82,400	143,500	126,900
Asia:						
China	3,600,000	3,300,000	2,584,000	2,067,200	2,067,200	2,067,200
Chosen	3,300,000	2,800,000	1,571,100	2,705,800	2,643,800	2,510,200
East Indies—						
British	735,000	650,000	600,000	500,000	600,000	600,000
Dutch	1,836,400	1,914,000	1,879,500	1,946,600	2,156,000	2,292,200
Federated Malay States	345,300	339,000	265,700	276,700	310,200	197,800
India, British	10,028,000	10,486,000	10,316,700	8,945,200	9,054,600	7,931,700
Indo-China	50,000	40,000	3,300	3,300	99,700	128,300
Japan	5,105,900	4,824,900	5,130,400	4,901,400	4,833,300	5,280,800
Sarawak		446,000	338,000	353,300	22,700	20,800
Taiwan	513,700	417,200	279,000	588,200	453,900	453,900
Africa	197,073,600	193,896,500	191,339,800	186,968,400	165,774,100	210,418,600
Australasia	29,268,600	26,911,500	22,651,700	18,672,700	18,847,200	18,127,800
	380,924,500	365,788,800	337,019,300	330,278,800	[c]319,420,100	[d]367,732,300

[a] Includes Philippine Islands.
[b] Reported as from Austria-Hungary.
[c] Revised figures.
[d] Revised figures will be given in the report for 1924.

WORLD'S PRODUCTION OF SILVER

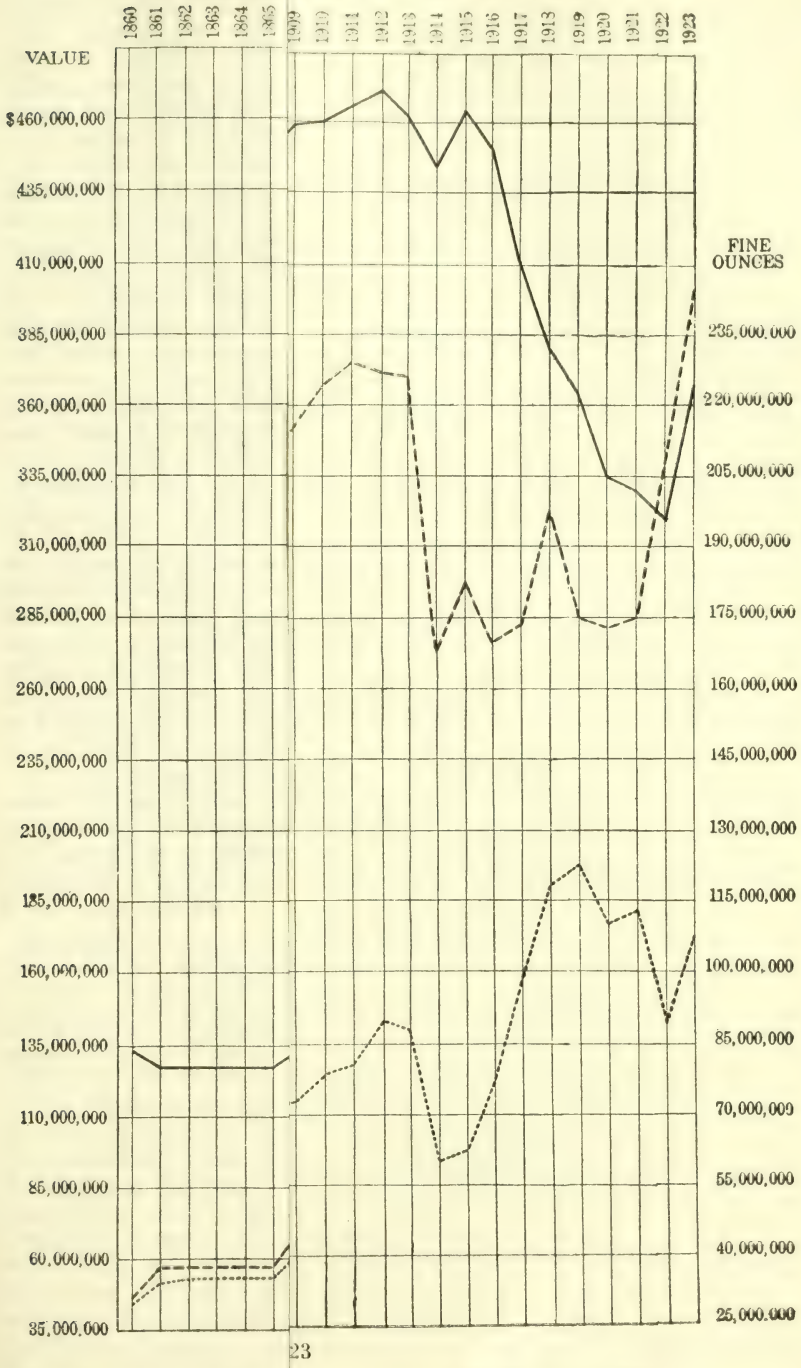
The figures for the world's production of silver in 1923 show that the United States and Canada produced 37 per cent, against 35 per cent in 1922, and that Mexico, Central America, and South America produced 49 per cent, so that only 14 per cent (33,777,700 ounces) came from all other countries, mainly from Australia, Burma, Japan, and Spain. There were increases of about 17,095,000 ounces in the United States, 9,782,000 ounces in Mexico, 628,300 ounces in Chile, 618,800 ounces in Burma, 5,485,000 ounces in Peru, and 2,343,000 ounces in Australasia. The total increase in the world's production was about 35,766,000 ounces, of which nearly half came from the United States. There has probably been a small increase in the world's production of silver in 1924, owing to increased activity at copper mines in the United States, Peru, and Chile, and at lead and zinc mines in Burma, Mexico, and Australia.

As the silver from domestic mines was, until June, 1923, purchased by the United States Mint, all the silver consumed in the arts and industries to that date was obtained from foreign sources. After June, 1923, producers of domestic silver had to sell in the open market at a price which was 36 to 38 cents an ounce lower than that paid under the Pittman Act. The open-market price has been fairly stable and higher than was expected, owing to large sales to India and in some degree to purchases for coinage by European countries, although the lower price has resulted in closing a number of mines in the United States from which siliceous ores containing a little silver were being mined. The value of the silver produced in the world in 1923, at $0.70028 a fine ounce, was about $171,976,000, and the total value from 1860 to 1923, inclusive, was $6,399,771,000.

World's production of silver, 1918–1923, in fine ounces

Country	1918	1919	1920	1921	1922	1923
North America:						
Canada	21,284,600	16,020,700	12,793,500	13,134,900	18,581,400	17,754,700
Central America	2,900,000	2,800,000	2,700,000	2,000,000	2,000,000	2,500,000
Mexico	62,517,000	65,904,200	66,662,200	64,465,400	81,076,900	90,859,100
United States [a]	67,810,100	56,682,400	55,361,600	53,052,400	56,240,100	73,335,200
South America:						
Argentina	25,000	25,000	30,000	25,000	25,000	30,000
Bolivia	2,435,000	2,435,000	2,200,000	2,758,900	5,373,500	5,212,800
Brazil	25,000	25,000	30,000	33,000	25,700	28,600
Chile	1,900,000	1,900,000	2,604,400	2,200,000	2,709,200	3,337,500
Colombia	325,000	494,300	480,000	500,000	3,200	3,100
Ecuador	40,000	40,000	35,000	75,000	75,000	75,000
Guiana	8,000	8,000	8,000	9,000	9,000	8,500
Peru	10,800,000	9,821,700	9,196,300	10,008,600	13,169,800	18,654,800
Uruguay			500	2,000	2,000	2,000
Venezuela	3,000	4,100	3,500	2,700	2,700	2,700
Europe:						
Austria	[b] 1,750,000	15,400	14,000	10,500	8,600	14,200
Czechoslovakia	554,800	581,000	680,100	703,100	875,200	900,200
France		12,000	321,500	321,500	209,000	213,000
Germany			3,305,000	3,387,400	3,581,500	3,215,000
Great Britain	50,000	68,400	76,400	11,300	27,600	34,600
Greece	350,000	160,000	220,900		184,100	184,100
Italy	500,000	350,000	297,500	199,300	204,700	306,600
Norway	270,200	312,800	323,200	196,100	205,200	257,600
Rumania				96,500	83,300	195,300
Russia	400,000	400,000	50,000	40,000	150,000	192,900
Serbia	20,000	20,000				
Spain	3,100,000	1,548,200	2,956,500	2,679,400	2,778,200	2,846,100
Sweden	31,500	31,500	11,600	13,300		600
Turkey	400,000	100,000	100,000	100,000	8,000	8,000
Yugoslavia			15,000	15,900	26,800	24,600
Asia:						
British India	270,000	190,600	170,600	150,000	150,000	150,000
Burma	1,970,500	1,975,000	2,700,000	3,437,600	4,094,300	4,713,100
China	70,000	65,000	50,000	40,000	100,000	100,000
Chosen	26,000	20,000	1,200	3,000	10,700	39,300
Dutch East Indies	400,000	1,006,800	1,027,900	1,022,000	1,109,600	1,409,000
Indo-China	1,000	1,000				
Japan	6,600,400	4,950,500	4,892,400	4,187,700	3,886,300	3,554,800
Sarawak		6,300	5,200	3,400	500	
Taiwan	26,900	25,000	20,000	26,500	23,400	23,400
Africa:						
Algeria		170,800	150,000			
Belgian Congo	10,500	10,000	10,700	5,800	6,500	8,800
Egypt	800	300	300			
French East Africa	20,000	17,700	13,800	12,900	12,900	13,000
Portuguese East Africa	1,200	1,000	700	500	500	
Rhodesia	175,700	180,600	164,900	161,900	184,400	171,500
Transvaal, Cape Colony, Natal	877,500	891,300	891,300	830,800	1,115,700	1,373,900
Australasia	10,000,000	7,188,000	2,684,900	5,362,200	11,484,900	13,828,100
	197,949,700	176,459,600	173,260,600	171,285,500	[c] 209,815,400	[d] 245,581,700

[a] Includes Philippine Islands.
[b] Reported as from Austria-Hungary.
[c] Revised figures.
[d] Revised figures will be given in the report for 1924.



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QUANTITY AND VALUE OF GOLD AND SILVER PRODUCED IN THE WORLD, 1860–1923

Most of the world's output of silver is produced or refined in the United States, but a large part of it is consumed in Great Britain, India, and China, and the price of silver has been dominated by the London market. "Silver, its romance and history," by Benjamin White, contains information relating to the buying and selling of silver and the fixing of market quotations, which was quoted in the chapter on gold and silver in Mineral Resources for 1918.

In 1923 the United States Senate appointed a commission to investigate and report to Congress by January 1, 1924, on the causes of the continuing decrease in the production of gold and silver; the causes of the depressed condition of the gold and silver industry in the United States; the production, reduction, refining, transportation, marketing, sales, and uses of gold and silver in the United States and elsewhere; and the effect of the decreased production of gold and silver on commerce, industry, exchange, and prices. The members of this commission are Senators Oddie and Pittman, of Nevada; Senator Walsh, of Montana; Senator Gooding, of Idaho; and Senator Sterling, of South Dakota. H. N. Lawrie is assistant to the commission, and C. E. Alden is secretary. The members of the commission and the owners of mines protested vigorously against the ruling of the Secretary of the Treasury regarding allocations of silver to the mint for subsidiary coinage, and a bill was prepared to be submitted to Congress authorizing the purchase by the Treasury of about 14,000,000 fine ounces additional of silver which it is claimed should have been purchased under the Pittman Act. The commission also promptly took action to collect all available data on the subjects assigned, and the assistant to the commission prepared a summary entitled "Gold and silver statistics," which contains tables and charts derived from the United States Geological Survey, Bureau of the Mint, Department of Commerce, and other sources.

The financial and investment division of the Department of Commerce, at the request of the commission, has issued a report (Bulletin 140) entitled "Changes in the monetary uses of silver since 1914," by Leland Rex Robinson, containing data obtained through the American consular service. An analysis of the information received is given as follows:

> The use of silver for reserve purposes has declined since 1914 in most countries, both absolutely and in proportion to gold and other forms of cover for issues of notes; numerous facts have operated to reduce the relative importance of silver as a circulating medium, in many countries there has been a reduction in the fineness or content of silver coins, and no movement appears to be in progress that would justify an assumption that silver will soon regain its pre-war relative position as reserve for issues of notes or as a circulating medium.

The committee appointed by the representatives of nearly all the large producers and marketers at a meeting held at Reno, Nev., in September, 1923, with the object of devising methods of helping the mining industry to obtain a reasonable profit on mining gold and silver, made a thorough investigation of both the legal and the financial aspects of a proposed association. This investigation, which was very thorough, was made by eminent financiers, lawyers, and mine officials. It took about 10 months and was materially aided by further data procured by the Senate Commission on Gold and Silver Inquiry. All the facts and the opinions, both legal and financial, were presented at a conference held in Salt Lake City, Utah, in August, 1924. As the report made showed no legal hindrance

to the formation of an association it was unanimously decided to form one with the title "American Silver Producers' Association." Articles for such an organization were signed by representatives of practically every large silver producing or marketing interest. The expressed purpose of the association is to advise, aid, and support legislation and other procedure tending to lower the cost of producing, reducing, and transporting silver and to promote its orderly marketing; to eliminate discriminations against the industry; and to subserve and protect all those engaged in the production of silver in the United States and elsewhere. The membership was limited to the American continent, and the annual dues were fixed at one-tenth of a cent per ounce of silver produced. It was generally recognized that the purchase of silver by European countries for subsidiary coinage would result in higher prices for silver bullion and that short-time credits would greatly expedite such purchases. Poland has purchased 6,000,000 ounces, which is to be coined at the United States Mint in Philadelphia, and the payment for it has been deferred until delivery of the coins. Most of the silver coins in Europe had been melted up and sold during and shortly after the World War, millions of ounces of silver being thus dumped on the market, and much of the coinage was debased and reminted. It has been estimated that the restoration of silver currency in Europe would require the purchase of 60,000,000 to 70,000,000 fine ounces of silver, so that giving credit to countries for large purchases would help the market price of silver. Meanwhile, the controlling factor has been the unusually large demand from India and China, the continuance of which depends on good crops in those countries and on the settlement of internal war in China.

MINE REPORT

METHOD OF COLLECTING STATISTICS

The first table in this report presents the final official figures of the production of gold and silver in the United States in 1923 as agreed upon by the Bureau of the Mint and the United States Geological Survey. With the comparatively unimportant exceptions of domestic gold and silver contained in ore and matte exported for reduction during the year, these figures record the production of gold and silver bullion from domestic ore in marketable form as metals, either refined or unrefined.

To trace this total gold and silver produced back to its source by States, counties, and mining districts, the Geological Survey makes a systematic investigation of the "mine production" of ores containing gold and silver and of the output of the placer mines, the output being classified by methods of production and by kinds of ore, as well as by mining districts. The resulting figures form the basis of the mine reports.

Of the two plans for ascertaining the gold and silver production, one is a measure of the mining industry and the other a measure of the metallurgic industry; one reports the mine output and its recoverable content and the other the metal actually recovered in marketable form. The two methods will not produce exactly corresponding results, but the figures for a period of years sufficiently long to compensate for overlap or lag should agree within allowable limits of error.

Gold and silver produced in the United States, 1905–1923, according to mint and to mine returns

Year	Mint		Mine	
	Gold	Silver	Gold	Silver
		Ounces		*Ounces*
1905–1915	$1,038,286,100	671,818,275	$1,031,369,692	672,280,562
1916	92,590,300	74,414,802	92,822,430	78,875,176
1917	83,750,700	71,740,362	82,032,745	70,665,531
1918	68,646,700	67,810,139	67,701,936	68,063,090
1919	60,333,400	56,682,445	58,225,112	51,907,869
1920	51,186,900	55,361,573	50,537,281	56,559,022
1921	50,067,300	53,052,441	49,788,750	46,359,147
1922	48,849,100	56,240,048	48,932,109	61,235,983
1923	51,734,000	73,335,170	51,400,382	70,393,639
	1,545,444,500	1,180,455,255	1,532,810,437	1,176,340,019

These figures show, according to the reports of the mint, a total excess of gold for the 19 years of $12,634,063, or a difference of about 0.8 per cent, and a total excess of silver of 4,115,236 ounces, or a difference of about 0.35 per cent. The small differences are fully accounted for in the detailed discussions of the subject in previous reports of this series.

UNITS OF MEASUREMENT

In the measurement of ores and concentrates the short ton of 2,000 pounds is used throughout. The price of gold is fixed by law at $20.67+ per fine ounce. The annual average prices for silver from 1914 to 1923 are given on page 551.

PRODUCTION OF GOLD AND SILVER REPORTED FROM THE MINES

Mine production of gold and silver in the United States in 1923

State or Territory	Gold		Silver		Increase or decrease	
	Fine ounces	Value	Fine ounces	Value	Gold	Silver (fine ounces)
Alabama	5.51	$114	1	$1	+$114	+1
Alaska	289,539.56	5,985,314	814,649	668,012	−1,437,053	+84,704
Arizona	296,109.23	6,121,121	7,343,742	6,021,868	+2,596,987	+2,811,878
California	647,209.75	13,379,013	3,559,443	2,918,743	−1,291,333	+459,378
Colorado	318,870.05	6,591,629	5,334,488	4,374,280	+218,210	−521,423
Georgia	25.59	529	2	1	−2,695	−362
Idaho	37,124.28	767,427	7,673,662	6,292,403	+266,022	+1,591,797
Illinois			8,170	6,699		+2,145
Michigan			223,997	183,678		−152,993
Missouri			177,270	145,361		−35,386
Montana	85,079.43	1,758,748	13,380,862	10,972,307	+101,991	+912,711
Nevada	204,292.89	4,223,109	10,614,564	8,703,942	+925,725	+1,994,977
New Mexico	26,689.12	551,713	747,127	612,644	+139,020	−5,113
North Carolina	53.31	1,102	78	64	−837	+69
Oregon	24,091.14	498,008	96,322	78,984	−33,560	−55,490
Pennsylvania	157.03	3,246	3,005	2,464	+646	+790
Philippine Islands	81,576.08	1,686,327	37,781	30,980	+159,927	+9,787
Porto Rico	4.85	100	184	151	+100	+184
South Carolina	15.14	313	1	1	+281	+1
South Dakota	309,905.05	6,406,306	95,844	78,592	−111,482	−22,916
Tennessee	320.00	6,615	105,712	86,684	+2,295	+27,371
Texas	38.80	802	811,824	665,696	+802	+166,844
Utah	148,824.86	3,076,483	19,137,470	15,692,725	+779,628	+1,866,370
Virginia					−706	−6
Washington	16,547.49	342,067	227,187	186,293	+155,102	+22,141
Wyoming	14.32	296	254	208	−911	+197
	2,486,493.48	51,400,382	70,393,639	57,722,781	+2,468,273	+9,157,656

The preceding table gives the quantity and value of the recoverable gold and silver ("mine production") by States reported from the producing mines in 1923 to the United States Geological Survey and the increase or decrease by comparison with the corresponding figures for 1922.

The increase of $2,468,273 in the mine production of gold in 1923 followed decreases of $856,641 in 1922, $748,531 in 1921, $7,687,831 in 1920, $9,476,824 in 1919, $14,330,809 in 1918, and $10,789,685 in 1917. The increase of 9,157,656 ounces in silver followed an increase of 14,876,836 ounces in 1922.

The principal gold-producing States in 1923 were California, Colorado, South Dakota, Arizona, Alaska, and Nevada, and these six States made 83 per cent of the total output. The notable increases in gold were in Arizona, Nevada, Utah, Idaho, Colorado, the Philippine Islands, Washington, New Mexico, and Montana. The most notable decreases in gold were in Alaska, California, and South Dakota.

The principal silver-producing States in 1923 were Utah, Montana, Nevada, Idaho, Arizona, and Colorado, and these six States produced 90 per cent of the total.

About $28,465,500 in gold, or 55 per cent of the entire output in the United States in 1923, was produced by 25 companies, none of which produced less than $350,000. The largest producer was the celebrated Homestake mine, in South Dakota. Sixteen of the larger properties produced gold from dry and siliceous ores, four produced it from gravel by dredging, and five from copper ore. Eight of the largest producers of gold in 1923 were in California, four each in Arizona and Colorado, three each in Alaska and Nevada, and one each in Montana, South Dakota, and Utah.

Larger producers of gold in the United States in 1923, in order of output

Rank	Operator	State	Mining district	Source of gold
1	Homestake Mining Co	South Dakota	Whitewood	Dry and siliceous ore.
2	Yuba Consolidated Goldfields	California	Marysville	Dredging gravel.
3	Cresson Consolidated Gold Mining & Milling Co.	Colorado	Cripple Creek	Dry and siliceous ore.
4	United Eastern Mining Co	Arizona	Oatman	Do.
5	Natomas Co. of California	California	Oroville and Folsom	Dredging gravel.
6	Utah Copper Co	Utah	West Mountain	Copper ore.
7	Alaska Juneau Mining Co	Alaska	Juneau	Dry and siliceous ore.
8	Empire Mines	California	Grass Valley	Do.
9	Portland Gold Mining Co	Colorado	Cripple Creek	Do.
10	Carson Hill Gold Mines	California	Mother Lode	Do.
11	North Star Mines	do	Grass Valley	Do.
12	United Comstock Mining Co	Nevada	Comstock	Do.
13	Tomboy Gold Mines Co	Colorado	Upper San Miguel	Do.
14	Original 16 to 1 Mine	California	Allegheny	Do.
15	Nevada Consolidated Copper Co.	Nevada	Robinson	Copper ore.
16	Chichagoff Mining Co	Alaska	Sitka	Dry and siliceous ore.
17	Calumet & Arizona Mining Co.	Arizona	Warren	Copper ore.
18	Tom Reed Gold Mining Co	do	Oatman	Dry and siliceous ore.
19	Kennedy Mining Co	California	Jackson	Do.
20	Tonopah Extension Mining Co.	Nevada	Tonopah	Do.
21	Smuggler Union Mining Co	Colorado	Upper San Miguel	Do.
22	Phelps Dodge Corporation (Copper Queen).	Arizona	Warren	Copper ore.
23	Hammon Consolidated Gold Fields.	Alaska	Nome	Dredging gravel.
24	Anaconda Copper Mining Co	Montana	Summit Valley	Copper ore.
25	Marysville Dredge Co	California	Marysville	Dredging gravel.

Besides the output of gold by these large operators, $22,935,000 came from about 3,450 placer and deep mines, many of which produced between $100,000 and $300,000 each. Hundreds of mines, especially placer properties in California, Oregon, Idaho, Alaska, Arizona, and the Appalachian States, produced very small quantities of gold, and the average output of the smaller mines was $6,600.

The largest output of silver was that of the mines operated by the Anaconda Copper Mining Co., followed by the Chief Consolidated Mining Co. Of the mines enumerated in the subjoined list, four recovered silver from copper ore, four from lead ore, nine from dry and siliceous ores, three from lead ore and siliceous ore, one from copper ore and siliceous ore, two from zinc ore and copper ore, one from lead-zinc ore and lead ore, and one from copper-lead ore. The California Rand mine, in California, and the Presidio mine, in Texas, were the largest producers of silver from ore that contained no appreciable quantity of any other metal. The output of the 25 properties listed was 40,863,100 ounces, or 58 per cent of the total. Six of the largest producers were in Utah, five in Nevada, four each in Montana and Idaho, three in Arizona, and one each in California, Colorado, and Texas. None of the 25 companies produced less than 660,000 ounces in 1923.

Larger producers of silver in the United States in 1923, in order of output

Rank	Operator	State	Mining district	Source of silver
1	Anaconda Copper Mining Co.	Montana	Summit Valley (Butte).	Copper ore.
2	Chief Consolidated Mining Co.	Utah	Tintic	Lead and siliceous ore.
3	Tintic Standard Mining Co	do	do	Do.
4	California Rand Silver (Inc.)	California	Randsburg	Dry and siliceous ore.
5	Park Utah Mining Co	Utah	Blue Ledge	Siliceous and lead ore.
6	United Verde Copper Co	Arizona	Verde	Copper and siliceous ore.
7	Tonopah Extension Mining Co.	Nevada	Tonopah	Dry and siliceous ore.
8	Silver King Coalition Mining Co.	Utah	Uintah	Lead ore.
9	Park City Mining & Smelting Co.	do	Snake Creek	Lead and lead-zinc ore.
10	Butte & Superior Mining Co	Montana	Summit Valley	Zinc and copper ore.
11	Federal Mining & Smelting Co.	Idaho	Hunter and Warm Springs.	Lead ore.
12	United Comstock Mining Co	Nevada	Comstock	Dry and siliceous ore.
13	Elm Orlu Mining Co	Montana	Summit Valley (Butte).	Zinc and copper ore.
14	West End Consolidated Mining Co.	Nevada	Tonopah	Dry and siliceous ore.
15	Hercules Mining Co	Idaho	Lelande	Lead ore.
16	Phelps Dodge Corporation	Arizona	Warren	Copper ore.
17	Tonopah Mining Co	Nevada	Tonopah	Dry and siliceous ore.
18	Tonopah-Belmont Development Co.	do	do	Do.
19	Smuggler Union Mining Co	Colorado	Upper San Miguel and Sneffels.	Do.
20	Presidio Mining Co	Texas	Shafter	Siliceous silver ore.
21	Davis-Daly Copper Co	Montana	Summit Valley (Butte).	Copper ore.
22	Vipont Silver Mining Co	Utah	Ashbrook	Dry and siliceous ore.
23	Hecla Mining Co	Idaho	Leland	Lead ore.
24	Calumet & Arizona Mining Co.	Arizona	Warren	Copper ore.
25	Talache Mines (Inc.)	Idaho	Pend Oreille	Copper-lead ore.

MINE PRODUCTION OF GOLD AND SILVER, BY STATES

ALASKA

The total production of gold in Alaska from the earliest mining in 1880 to the end of 1923 is estimated at $341,511,774, and that of silver 12,278,241 fine ounces.

Gold.—The yield from siliceous ore decreased from $3,012,211 in 1922 to $2,341,596 in 1923, and that from copper ore increased from $15,064 to $33,633; the placer output decreased from $4,395,000 to $3,608,500. Twenty-five dredges produced $1,848,596 of the placer gold, which was $80,843 more than the dredge output in 1922.

The 2,502,901 tons of siliceous ore treated in 1923 yielded an average of $0.95 in gold and silver to the ton, and the 731,168 tons of copper ore contained $0.85 in gold and silver to the ton.

About 40 per cent of the total output of gold in Alaska in 1923 came from gold lode mines, against 41 per cent in 1922. Placers yielded 6,015,600 cubic yards of auriferous gravel, of which the dredges handled 4,645,000 cubic yards and made an average recovery of 40 cents a cubic yard, against 55 cents in 1922. The estimated total recovery of gold by dredging for the period 1903–1923 is $26,723,801.

Silver.—The mine production of silver in Alaska in 1923 was 814,649 fine ounces, against 729,945 ounces in 1922. Copper ore yielded 715,040 ounces, siliceous ore 57,763 ounces, placers 22,372 ounces, lead ore 13,374 ounces, and copper-lead ore 6,100 ounces.

ARIZONA

Gold.—Of the mine production of gold in Arizona in 1923, placers contributed only $8,854. The deep mines produced $6,112,267, of which 62 per cent came from dry and siliceous ore mined chiefly in Mohave, Yavapai, and Cochise counties, and 36 per cent was contained in copper ore mined chiefly in Yavapai and Cochise counties. Mohave County had a gold output of $2,808,342, Yavapai County $1,902,378, and Cochise County $1,060,254. The gold recovered from ore and tailings treated at gold and silver mills represented 48 per cent of the total deep-mine output, against 60 per cent in 1922, and crude ore shipped to smelters contained 46 per cent. The crude copper ore mined and smelted directly (without previous concentration) contained an average gold output of about 73 cents a ton.

Silver.—Of the mine production of silver in Arizona, 4,269,278 ounces came from copper ore, 1,968,675 ounces from dry and siliceous ore, 1,090,534 ounces from lead ore, and 15,183 ounces from copper-lead ore. Cochise County produced 2,713,630 ounces in 1923, of which 1,485,443 ounces came from copper ore and 576,517 ounces from siliceous ore; and Yavapai County produced 2,879,763 ounces, mainly from copper ore. Bullion recovered from gold and silver ores, almost all by cyanidation, contained 247,601 ounces of silver, concentrates 1,116,891 ounces, and crude ore shipped to smelters 5,972,105 ounces.

CALIFORNIA

Gold.—In 1923 the deep mines of California produced $6,856,430 in gold (a decrease of $2,314,061), of which gold-quartz ore yielded 94 per cent, and the placers $6,522,583 (an increase of $1,022,728). Of the placer production, $6,065,735 was recovered by dredging.

The total dredge production from 1896 to the end of 1923 has been $136,064,934, and the production by dredges in 1923 was equal to 45 per cent of the total for the year. The eight Yuba County dredges made the largest output, the value being $3,139,512, an increase of $654,107. Six dredges in Sacramento County made an output of $1,323,315, a decrease of $26,098. In Butte County, including Oroville and other districts, four dredges produced $391,136, or $63,158 less than in 1922. Dredges were also operated in Calaveras, Placer, Shasta, Stanislaus, and Trinity counties.

Five of the 32 counties reporting mine production of gold had a yield of more than $1,000,000 each in 1923. Of these Yuba and Sacramento counties obtained most of their gold by dredging, Amador and Calaveras counties are on the Mother Lode, and Nevada County produced gold mainly from siliceous ore of the Grass Valley district. The five Mother Lode counties—Amador, Calaveras, Eldorado, Mariposa, and Tuolumne—whose output is mainly gold milling ore, produced $2,391,203 in gold from mill bullion and $538,830 from concentrates made from gold ore in 1923, against $2,812,336 from mill bullion and $876,572 from concentrates in 1922.

Silver.—Of the mine production of silver in California in 1923, siliceous ore yielded 2,845,764 ounces, copper ore 360,345 ounces, lead ore 330,241 ounces, copper-lead ore 2,788 ounces, and placers the remainder. The only counties producing more than 100,000 ounces of silver in 1923 were Inyo, Plumas, and San Bernardino. About 72 per cent of the silver was recovered from ore sent to concentrating plants.

COLORADO

Gold.—The total mine production of gold in Colorado in 1923 showed a moderate increase from 1922 but was $12,562,192 less than in 1916. The Cripple Creek district, with an increase of $9,426, produced $4,047,008 in gold, or 61.4 per cent of the State output.

The San Juan region, in Dolores, La Plata, Ouray, San Juan, and San Miguel counties, produced $1,693,956; and Lake County produced $271,504, a decrease of $141,554. Siliceous and dry ores, forming 74 per cent of all the ore sold or treated, yielded 89 per cent of the total output of gold; nearly 4 per cent came from lead-zinc ore, 5.5 per cent from placers, and the remainder from ore of other classes. The gold recovered by amalgamation from 664,450 tons of ore amounted to 96,805 fine ounces, and that recovered by cyanidation to 124,217 fine ounces.

The placer production in 1923 was 17,629.25 ounces, an increase of 388.25 ounces. Dredges in Summit County produced 55 per cent of the placer gold.

Silver.—Lake County, principally Leadville, produced 655,838 ounces of silver, a decrease of 296,210 ounces. San Miguel County produced 1,606,344 ounces, a decrease of 39,115 ounces. Eagle County produced 322,143 ounces and Ouray County 840,044 ounces. Siliceous and dry ores yielded 74 per cent of the silver recovered, and lead ore nearly 12 per cent.

IDAHO

Gold.—The total production of gold in Idaho from the discovery of placer gold in 1863 to the end of 1923 is estimated by C. N. Gerry at $134,627,176.

Shoshone County produced about 36 per cent of the total output in 1923. The lode mines produced $268,718 in gold and the placers $498,709, of which $469,900 was won by dredging. The total output of gold recovered by dredges from 1897 to the end of 1923 has been $5,068,287. Of the total gold in 1923, about 65 per cent came from placers, 18 per cent from siliceous ore, 4 per cent from copper ore, and the remainder from lead, copper-lead, and lead-zinc ores.

Silver.—The total mine production of silver in Idaho for the period 1863 to 1923, inclusive, amounts to 266,620,200 fine ounces.

Shoshone County produced 80 per cent of the total silver in 1923, against 77 per cent in 1922. Lead ore contained 71.5 per cent of the output, lead-zinc ore 15 per cent, and copper-lead ore 12 per cent. Crude ore shipped, which averaged 17 ounces of silver to the ton, supplied about 22 per cent of the silver, and concentrates, which averaged 22.61 ounces of silver to the ton, contained 78 per cent.

MICHIGAN

The copper mines of Michigan produced silver mainly from the electrolytic treatment of about 9,151,100 pounds of copper.

MISSOURI, OKLAHOMA, ILLINOIS, AND KENTUCKY

The lead and zinc mines of the Central States produce no gold and only a small quantity of silver. Nearly all the silver is a by-product from the refining of lead from concentrates of lead ores mined in southeastern Missouri. The total yield of silver from Missouri in 1923 was derived from lead recovered from 118,000 tons of galena concentrates.

The lead-zinc-fluorspar deposits of the Kentucky-Illinois field carry silver, and the average silver recovery from lead concentrates from Illinois in 1923 was 4.64 ounces to the ton. No silver ore was shipped from the Criswell mine, near Byars, McClain County, Okla., in 1923.

MONTANA

Gold.—The placer output of gold in Montana was $40,779, a decrease of $31,007. Madison County had the largest placer output, $14,755, nearly all of which was recovered in Alder Gulch. Lewis and Clark County produced $321,003, mostly from gold ore, and Silver Bow County $627,585, chiefly from copper and silver ores. At amalgamation and cyanidation plants $789,131 in gold was recovered, an average of $3.68 per ton of ore and tailings treated. Ore treated at concentration mills yielded concentrates containing $640,602, or 43 cents a ton, and crude ore shipped to smelters contained $281,360 in gold, an average of $1.57 a ton.

Silver.—Copper ore from Montana mines yielded 7,619,864 ounces of silver in 1923 (an average of 1.72 ounces a ton), of which Silver Bow County (Butte) supplied 7,614,214 ounces. The lead-zinc ore yielded 1,582,548 ounces. The dry and siliceous ores yielded 1,280,235 ounces, of which Silver Bow County supplied 528,125 ounces from silver ore.

NEVADA

Gold.—The mine production of gold in the Goldfield district of Nevada in 1923 was $92,743, against $264,041 in 1922. Nye County produced $1,642,719, of which $1,107,329 came from Tonopah, where

there was a decrease of $71,973. Siliceous ore yielded 167,194.50 fine ounces and copper ore 29,551.13 ounces.

Silver.—Nye County (almost wholly the Tonopah district) again led in the production of silver, with 5,232,433 ounces, or 321,130 ounces less than in 1922. All but 1,530,508 ounces came from dry and siliceous ores, and 79 per cent of the State output was recovered by cyanidation.

NEW MEXICO

Gold.—The mine production of gold in New Mexico in 1923 came mainly from Catron County, which produced $179,351; Hidalgo County, $216,924; Grant County, $85,288; and Colfax County, $50,536.

Copper ore contained 13,851 ounces of gold, against 6,806 ounces in 1922, and dry and siliceous ores contained 12,513 ounces. The output from lead ore was 121 ounces, and the placer output was 204 ounces.

Silver.—Catron County produced 398,714 fine ounces of silver, all from siliceous ore, and Hidalgo County produced 149,783 fine ounces, mainly from copper ore. Copper ore yielded a total of 164,699 ounces, and lead and copper-lead ores only 37,791 ounces. The output of silver from Grant County decreased from 150,844 ounces in 1922 to 94,392 ounces in 1923.

OREGON

Gold.—The placer mines in Oregon produced $276,770 in gold in 1923, or $69,367 less than in 1922. Of the output from deep mines, which produced $221,238, an increase of $35,807, 70 per cent was obtained from siliceous ore. Two dredges in Baker County and one dredge in Grant County produced $224,117, and a few drift and hydraulic mines and surface placers in Baker, Coos, Curry, Douglas, Grant, Jackson, Josephine, Malheur, and Wheeler counties produced the remainder of the placer gold. Baker and Grant counties produced more than $150,000 in gold each.

Silver.—Of the total production of silver, 71,749 ounces came from siliceous ore, 22,511 ounces from copper ore, and 2,062 ounces from placer bullion.

SOUTH DAKOTA

The total value of the gold produced in South Dakota from 1876 to the end of 1923 was $243,152,930, and the total output of silver for the same period was 7,128,061 fine ounces.

Gold.—The mine production of gold in South Dakota in 1923 was derived almost wholly from siliceous milling ore of low grade. About 70 per cent of the output was recovered by amalgamation, and nearly all the remainder by cyanidation. The Homestake mines and mills produced $6,400,078.42 in gold bullion from 1,652,337 tons of ore treated.

Silver.—The mine output of silver was derived mainly from refining the gold bullion produced.

SOUTHERN APPALACHIAN AND EASTERN STATES

Gold.—The total production from 1799 to the end of 1923 in the southern Appalachian States, as shown from data compiled by the Bureau of the Mint and the United States Geological Survey, has

been $51,064,105. The data credit Alabama with $766,746, Georgia with $17,829,719, North Carolina with $23,635,361, Tennessee with $280,537, Virginia with $3,298,032, South Carolina with $5,182,305, and Maryland with $71,405.

The combined mine production of gold in the southern Appalachian States in 1923 was $8,673, against $10,221 in 1922. Tennessee led, and North Carolina was next. The gold produced in Tennessee was derived from copper ore of the Ducktown district. The gold and silver produced in Pennsylvania was derived from copper concentrates from pyritiferous magnetite ore. The production of gold from placers amounted to 49.34 ounces. Copper ore in Tennessee yielded about 320 ounces of gold, and copper ore in North Carolina 29.03 ounces. Siliceous ore, nearly all from North Carolina, yielded only 21.18 ounces.

Silver.—Copper ore in Tennessee yielded 105,712 ounces of silver in 1923, and copper ore in North Carolina 74 ounces. Siliceous ore and placer bullion yielded only 8 ounces.

TEXAS

The total output of gold from Texas mines from 1885 to the end of 1923 is given by Charles W. Henderson as $44,409, and the output of silver for the same period was 17,267,304 ounces.

Gold.—The small annual yield of gold has been mainly a by-product.

Silver.—The greater part of the silver produced in Texas continued to come from the Presidio mine, and the remainder was derived from small shipments of copper ore, lead ore, and siliceous ore from Hudspeth, Brewster, and El Paso counties. The silver derived from lead ore amounted to 7,757 ounces and that from copper ore to 1,764 ounces.

UTAH

Gold.—The total output of gold in Utah from 1864 to the end of 1923 is given by V. C. Heikes[2] as $107,385,773.

In 1923 the Bingham district, in Salt Lake County, produced $2,064,141, and the Tintic district, in Juab and Utah counties, $531,344. Placer gold amounted to $527, and the output recovered by cyanidation and amalgamation was about $59,600. About 56.6 per cent of the Utah gold was derived from copper ore, mined mainly in Salt Lake and Juab counties; lead and lead-zinc ores contained 21.4 per cent, and siliceous ore 22 per cent.

Silver.—The total output of silver in Utah from 1864 to the end of 1923 has been 452,893,629 fine ounces, according to V. C. Heikes.[2] In 1923 the largest production was made in Juab County, credited with 5,788,396 ounces, mainly from lead ore, against 6,338,689 ounces in 1922. Utah County had 3,466,310 ounces, mostly from lead and siliceous ores, against 2,217,547 ounces in 1922. Of the Salt Lake County output of 2,414,780 ounces, the Bingham district produced 2,046,071 ounces. The Tintic district, in Juab and Utah counties, produced 9,231,960 ounces, mainly from lead and siliceous ores; and the Park City region, in Summit and Wasatch counties, produced 5,956,687 ounces, all from lead, lead-zinc, and siliceous

[2] U. S. Geol. Survey Mineral Resources, 1923, pt. 1, p. 417, 1925.

ores. Altogether in 1923 the lead ore of Utah yielded 10,648,952 ounces of silver, copper ore 867,618 ounces, lead-zinc ore 852,617 ounces, and dry and siliceous ores 6,737,300 ounces. The crude ore smelted in 1923 contained 14,561,434 ounces, and concentrates contained 3,347,890 ounces.

WASHINGTON

The total production of gold in Washington from earliest mining to the end of 1923 is given by C. N. Gerry[3] as $28,784,590, and the total production of silver as 8,397,278 fine ounces.

Gold.—Of the mine production of gold in Washington in 1923, 81 per cent was derived from ore shipped directly to smelters and 18 per cent came from gold and silver milling plants; siliceous ore supplied 98.8 per cent, and copper ore and lead ore together less than 1 per cent. Ferry County alone produced $276,605 in 1923, against $85,686 in 1922. All the gold produced in Ferry County in 1923 came from mines in the Republic district. Whatcom County produced $60,011 in gold.

Silver.—Of the mine production of silver Ferry County produced 97,991 ounces, mainly from siliceous ore; Stevens County 87,560 ounces, from copper ore and lead ore; and Okanogan County 30,926 ounces, mainly from siliceous ore.

WYOMING

The total production of gold in Wyoming from 1867 to the end of 1923 was $1,237,624, and the output of silver for the same period was 70,113 ounces.

Small shipments of copper ore containing gold, silver, platinum, and palladium were made from the Old Rambler mine, and some copper ore was shipped from the Williams mine, in Fremont County, and from the Sunrise mine, in Platte County. The total output of gold in 1923 was valued at $296, and that of silver at $208.

PHILIPPINE ISLANDS

Gold.—The output of gold in the Philippine Islands from 1907 to 1923, inclusive, has been $16,161,628. The mine production of gold in 1923 was $1,686,327, against $1,526,400 in 1922, $1,313,096 in 1921, $1,276,561 in 1920, $1,309,722 in 1919, $1,290,000 in 1918, $1,408,161 in 1917, $1,514,200 in 1916, $1,320,900 in 1915, $1,371,514 in 1914, $868,362 in 1913, and $570,212 in 1912. The yield of gold in 1923 from three deep mines producing siliceous ore was $1,588,446. The gold derived from placers amounted to $97,881.

The milling plant of the Benguet Consolidated Mining Co., in the Province of Luzon, the largest producer of gold in the Philippine Islands, is described in the Mining and Scientific Press of December 4 and 11, 1920. There was not much activity in 1923 except at the Benguet mine. The Syndicate mine was operated on low-grade ore, but the Colorado mine, at Aroroy, suspended operations. Dredging continued at Parascale, but that at Surigao ceased.

Silver.—The mine production of silver in the Philippine Islands in 1923 was recovered entirely from gold bullion refined, as no attempt was made to develop the known deposits of silver ore.

[3] U. S. Geol. Survey Mineral Resources, 1923, pt. 1, p. 405, 1925.

The annual report of the Benguet Consolidated Mining Co. for 1923 stated that 75,159 tons of ore (32,915 tons more than in 1922) was cyanided, yielding $16.62 a ton in gold and silver. The bullion recovered was valued at $1,139,765. The ore reserves were estimated to be 316,000 tons at the end of 1922. The capacity of the mill was increased to 200 tons a day, the net profit from operations in 1923 was $564,522, and the dividends paid amounted to $375,000.[4]

NUMBER OF PRODUCING MINES

The following table indicates the number of mines producing gold and silver in 1923. The placers are those in which the gold and the silver in natural alloy with the gold and, in a few placers, with platinum also are recovered from gravel and sand, whether by hand washing, sluicing, hydraulicking, drifting (in frozen ground or ancient buried river channels), or dredging. The deep mines are those producing gold and silver (from ore as distinguished from gravel) mainly from underground workings, including those whose ore is valuable chiefly for copper, lead, or zinc but which contribute precious metals as by-products. In addition to producing mines here enumerated, many properties were being prospected and developed, and many other mining claims were being held by assessment work only.

The enumeration of placer mines is less satisfactory than that of deep mines, because some of the operations are only temporary and individually small and because much of the production is made by transitory miners not regularly working placer ground. The unit so far as possible is, as for deep mines, not the operator but the mining claim or group of claims.

Number of mines in the United States producing gold and silver in 1923[a]

State	Placer	Deep	Total	State	Placer	Deep	Total
Alabama	1		1	North Carolina	2	5	7
Alaska	521	27	548	Oregon	151	55	206
Arizona	24	317	341	Pennsylvania [b]		1	1
California	353	268	621	South Carolina	1		1
Colorado	15	402	417	South Dakota		5	5
Georgia	3	1	4	Tennessee [b]		2	2
Idaho	85	146	231	Texas		8	8
Illinois [b]		3	3	Utah	4	146	150
Michigan [b]		4	4	Washington	6	30	36
Missouri [b]		3	3	Wyoming		3	3
Montana	78	304	382				
Nevada	35	354	389		1,295	2,188	3,483
New Mexico	16	104	120				

[a] Philippine Islands and Porto Rico not included.
[b] Number of mines contributing to production of gold and silver.

Number of mines producing gold and silver, 1914–1923

Year	Placer	Deep	Total	Year	Placer	Deep	Total
1914	1,815	3,158	4,973	1920	1,012	2,331	3,343
1915	1,720	3,597	5,317	1921	1,357	1,967	3,324
1916	1,530	3,765	5,295	1922	1,359	2,206	3,565
1917	1,552	3,811	5,363	1923	1,295	2,188	3,483
1918	1,414	3,287	4,701				
1919	1,105	2,460	3,565	Average	1,416	2,877	4,293

The total number of properties operated in 1923 was 1,256 less than the average for the last 18 years. The number of placer properties worked showed a decrease of 64, and the total was 1,021 less than

[4] Eng. and Min. Jour.-Press, Apr. 12, 1924, p. 631.

the number operated in 1906. This is a natural result of the exhaustion of the rich gravel and of the acquisition of large areas of placer ground by dredge companies. The number of deep mines operated was 18 less than in 1922 and 782 less than the average for 18 years, and fewer deep mines were operated than in any other year since 1906 except 1921.

ORE PRODUCTION, CLASSIFICATION, AND AVERAGE VALUE

The best index of deep mining is found in the quantity, metallic content, and value of ore mined, rather than in the number of mines or of operators. In the next table are given the production of ore from mines producing gold and silver and the average extraction value of precious metals per ton.

The classification adopted is necessarily arbitrary in part. The complex nature of western ores especially and the gradations from one well-recognized class to another render essential a fixed terminology. The dry and siliceous ores comprise gold and silver ores proper, as well as fluxing ores carrying considerable quantities of iron and manganese oxides and very small quantities of gold and silver, and precious metal bearing ores carrying copper, lead, or zinc in quantities too low to classify them as copper, lead, zinc, or mixed ores. The distinction between gold and silver ores is not here made. The total number of silver mines and the total production of true silver ore are both very small. The copper ores include those containing 2.5 per cent or more of copper, or less than this percentage in the great disseminated copper deposits of the West and in the Lake Superior ores; in general, the lead ores are those containing 4.5 per cent or more of lead and the zinc ores are those containing 25 per cent or more of zinc, both irrespective of their precious-metal content; but ores of lower grades in lead and especially in zinc are treated profitably in many districts, and of course they are then classified as lead or zinc ores, as the case may be. The mixed ores are combinations of those enumerated.

The lead, zinc, and lead-zinc ores in many districts in the Eastern and Central States carry no appreciable quantity of gold or silver, and such ores are excluded from this report.

The total quantity of ore sold or treated from which gold or silver was produced increased more than 20,350,000 tons in the four years prior to 1920, decreased 23,791,863 tons in 1921, and increased 13,609,082 tons in 1922 and 19,918,985 tons in 1923, when it amounted to 55,095,395 tons. In 1923, owing to the increased activities of the large mines, copper ore sold or treated increased 18,240,181 tons, but all other classes of ores increased only 1,678,804 tons.

Arizona led in quantity of ore, as its output was mainly copper ore. Utah was second, owing to its copper, lead, and siliceous ores. Montana was third, with an output of which about 77 per cent was copper ore. Nevada, Alaska, New Mexico, Idaho, South Dakota, Colorado, and California followed in order of output. The bulk of the ore from Alaska, South Dakota, Colorado, and California was low-grade siliceous ore, and that from Idaho was mainly lead ore. The larger part of the output of ore from Nevada was copper ore, though the production of siliceous ore was much larger than in 1922. All the ore from Michigan was low-grade copper ore, and about 95 per cent of the ore treated from New Mexico was copper ore.

Ore produced in the United States and average extraction value of gold and silver per ton in 1923 [a]

State or Territory	Dry and siliceous ores		Copper ore		Lead ore	
	Short tons	Average value	Short tons	Average value	Short tons	Average value
Alaska	2,502,901	$0.95	731,168	$0.85	64	$188.61
Arizona	566,293	9.58	16,331,974	.36	115,369	8.56
California	925,659	9.70	571,645	.83	38,304	7.96
Colorado	1,166,470	7.80	4,655	28.98	90,410	6.44
Georgia	1	16.00				
Idaho	24,059	7.94	41,901	2.20	1,192,442	3.81
Michigan [b]			400,000	.46		
Montana	342,253	6.37	4,420,601	1.50	105,450	3.86
Nevada	1,371,970	7.95	2,833,908	.24	84,764	12.61
New Mexico	66,842	10.55	2,946,800	.14	6,675	4.65
North Carolina	45	9.44	157	4.21		
Oregon	31,445	6.81	18,940	4.45		
Pennsylvania [c]			986,596	[c].29		
South Dakota	1,665,439	3.89				
Tennessee [d]			776,477	.12		
Texas	78,418	8.39	48	41.63	144	45.91
Utah	346,425	17.90	11,519,727	.21	645,991	14.20
Washington	33,499	13.20	11,128	4.63	7,881	3.94
Wyoming			584	.86		
	9,121,719	5.91	41,596,309	.42	2,287,494	7.56
Percentage	16.56		75.50		4.15	
1922: Total	8,728,222	6.98	23,356,128	.56	2,123,673	8.24
Percentage	24.81		66.40		6.04	

State or Territory	Zinc ore		Copper-lead and copper-lead-zinc ores		Lead-zinc ore		Total (short tons)
	Short tons	Average value	Short tons	Average value	Short tons	Average value	
Alaska			59	$92.93			3,234,192
Arizona			229	55.88	1,313		17,015,178
California			83	37.82			1,535,691
Colorado	93,000	$0.52	380	42.66	214,185	$3.34	1,569,100
Georgia							1
Idaho			52,291	15.41	452,827	2.04	1,763,520
Michigan [b]							400,000
Montana	540,738	3.33	106,325	2.67	228,168	5.96	5,743,535
Nevada	4,368	.08	330	76.88	59,597	2.75	4,354,937
New Mexico	82,390		571	4.27	7,772		3,111,050
North Carolina							202
Oregon							50,385
Pennsylvania [c]							986,596
South Dakota							1,665,439
Tennessee [d]							776,477
Texas							78,610
Utah	48	.96	971	26.65	239,836	3.82	12,752,998
Washington	3,450		942	2.23			56,900
Wyoming							584
	723,994	2.55	162,181	7.30	1,203,698	3.39	55,095,395
Percentage	1.31		0.29		2.19		100.00
1922: Total	471,172	3.68	52,370	13.76	444,845	7.89	35,176,410
Percentage	1.34		0.15		1.26		100.00

[a] Philippine Islands, Porto Rico, Illinois, and Missouri not included; quantity of crude ore containing gold and silver not known.
[b] Include only copper ore that yielded silver.
[c] From low-grade copper concentrates derived from pyritiferous magnetite ore; recovery per ton of concentrates.
[d] Zinc and lead ores yielded no gold or silver.

The value of the gold and silver recovered from sources other than siliceous ore and placer bullion in the United States (Philippine Islands and Porto Rico excluded) in 1923 was $42,070,078. Geological Survey reports show that this gold and silver was derived from about 46,000,000 tons of base ores, which yielded an average of 92 cents a ton. Of this average only about 15 cents represents gold.

The average recovery from siliceous ore in 1923 was $3.42 in gold a ton, so that a ton of siliceous ore yielded about 23 times as much gold as was derived from a ton of ore of all other classes and 26 times as much as was derived from copper ore, which constituted more than 75 per cent of the total quantity of ores containing gold and silver in 1923. For this reason it appears hopeless to expect any large increase in the production of gold in the United States by reason of increase in the quantity of base ores mined, even though the quantity should be doubled.

In 1923 the lead ore of Utah showed an average recovery in gold and silver of $14.20 a ton, and that of Idaho, which produced half of the total output of lead ore containing gold, only $3.81 a ton. In the output of ore considered as producing gold and silver, the proportion of dry and siliceous ores decreased greatly, being 16.6 per cent, compared with about 24.8 per cent in 1922, and the proportion of lead ore decreased from 6 to 4 per cent, whereas that of copper ore increased from 66 to 75 per cent. The proportion of other classes of ore, which together made up only 3.79 per cent of the total, also showed considerable increases except zinc ore. The average value per ton in gold and silver of all ores decreased considerably in 1923, as was natural with an increased output.

During the period 1906–1923 the peak of production of dry and siliceous ores was reached in 1916, though the proportion of such ores to the total was largest in 1906. The extraction value of these ores varies considerably in different years, depending to a large degree on the quantity of low-grade ores milled in Alaska and South Dakota. The decided decrease in the average extraction value of gold and silver in copper ore—from $1.55 a ton in 1906 to 42 cents in 1923—was caused by the low gold and silver content in the greatly increased quantity of copper ore derived from mines in Arizona, New Mexico, Nevada, and Utah. As silver predominates over gold in most of the lead ore, the average extraction value shows a wider range than the quantity of ore. Zinc ore formed less than 1 per cent of the total ore given in the following table, and its average extraction value in precious metals shows a considerable range. The copper-lead and copper-lead-zinc ores have been negligible in quantity, though increasing now, but they show a higher average extraction value than ore of any other class.

Ore produced in the United States and average extraction value of gold and silver per ton, 1914–1923 [a]

Year	Dry and siliceous ores		Copper ore		Lead ore	
	Short tons	Average value	Short tons	Average value	Short tons	Average value
1914	10,966,666	$6.95	27,653,352	$0.49	2,307,550	$5.29
1915	12,687,126	6.26	32,973,166	.51	2,429,546	4.86
1916	12,921,268	5.73	47,478,127	.51	2,373,579	5.95
1917	12,166,026	5.56	49,049,181	.49	2,494,077	6.88
1918	9,702,240	6.58	53,409,729	.50	2,356,585	8.24
1919	9,302,229	6.25	29,919,369	.61	1,815,243	9.33
1920	8,590,139	6.26	32,447,410	.52	2,368,619	8.26
1921	8,436,214	6.65	10,930,888	.54	2,053,575	7.89
1922	8,728,222	6.98	23,356,128	.56	2,123,673	8.24
1923	9,121,719	5.91	41,596,309	.42	2,287,494	7.56

[a] Philippine Islands, Porto Rico, Illinois, and Missouri excluded. Crude ore containing gold and silver not known.

Ore produced in the United States and average extraction value of gold and silver per ton, 1914–1923—Continued

Year	Zinc ore		Copper-lead and copper-lead-zinc ores		Lead-zinc ore		Total (short tons)
	Short tons	Average value	Short tons	Average value	Short tons	Average value	
1914	622,811	$0.19	11,577	$12.87	1,488,747	$2.90	43,050,703
1915	512,634	1.32	10,951	15.55	1,900,029	2.06	50,513,452
1916	833,345	1.21	79,992	5.54	2,702,091	2.31	66,388,402
1917	641,755	.90	31,675	14.58	2,793,613	2.82	67,176,327
1918	210,298	.76	15,698	16.19	2,352,350	3.47	68,046,900
1919	88,654	.52	17,632	15.97	1,365,945	4.91	42,509,072
1920	482,229	3.00	26,890	30.01	1,443,904	4.10	45,359,191
1921	10,116	.76	14,248	31.76	122,287	16.96	21,567,328
1922	471,172	3.68	52,370	13.76	444,845	7.89	35,176,410
1923	723,994	2.55	162,181	7.30	1,203,698	3.39	55,095,395

MINE PRODUCTION OF GOLD, BY SOURCES

As shown in the following table, more than 85.7 per cent of the domestic output of gold in 1923 was obtained from dry and siliceous ores—normally gold quartz and gold-silver quartzose ores—and from placers. The total contribution of gold derived from the great copper, lead, and zinc mines of the country is relatively small, notwithstanding their recent enormous development and production of ore, but this contribution in 1923 was greater than in 1922, owing to the larger quantities of base ores treated.

Mine production of gold in the United States in 1923, by States, in fine ounces [a]

State	Placers	Dry and siliceous ores	Copper ore	Lead ore	Zinc ore	Copper-lead and copper-lead-zinc ores	Lead-zinc ore	Total
Alabama and Georgia	30.33	0.77						31.10
Alaska	174,561.18	113,274.70	1,627.00	53.41		23.27		289,539.56
Arizona	428.31	184,458.86	106,691.21	4,514.11		16.74		296,109.23
California	315,529.97	321,456.79	8,523.74	1,654.38		44.87		647,209.75
Colorado	17,629.25	283,375.86	2,139.88	3,339.22	296.65	122.57	11,966.62	318,870.05
Idaho	24,125.05	6,570.14	1,516.80	2,066.00		2,587.09	259.20	37,124.28
Montana	1,972.68	54,743.81	19,776.67	2,368.15	3,019.08	271.05	2,927.99	85,079.43
Nevada	3,941.83	167,194.50	29,551.13	2,571.61	4.98	708.16	320.68	204,292.89
New Mexico	204.05	12,512.96	13,850.90	121.21				26,689.12
North Carolina and South Carolina	19.01	20.41	29.03					68.45
Oregon	13,388.75	7,520.41	3,181.98					24,091.14
Pennsylvania [b]			157.03					157.03
South Dakota		309,905.05						309,905.05
Tennessee			320.00					320.00
Texas			26.70	12.10				38.80
Utah	25.49	32,714.51	84,203.12	21,365.84		24.96	10,490.94	148,824.86
Washington	73.09	16,348.92	80.01	43.44		2.03		16,547.49
Wyoming			14.32					14.32
	551,928.99	1,510,097.69	271,689.52	38,109.47	3,320.71	3,800.74	25,965.43	2,404,912.55
Value	$11,409,385	$31,216,490	$5,616,321	$787,793	$68,645	$78,568	$536,753	$49,713,955
Percentage	22.95	62.79	11.30	1.58	0.14	0.16	1.08	100.00
1922: Total	537,909.69	1,560,788.75	130,928.12	35,415.63	2,807.49	2,466.80	22,934.68	2,293,251.16
Value	$11,119,580	$32,264,367	$2,706,525	$732,106	$58,036	$50,993	$474,102	$47,405,709
Percentage	23.46	68.06	5.71	1.54	0.12	0.11	1.00	100.00

[a] Philippine Islands and Porto Rico not included.

[b] From pyritiferous magnetite ore.

During the period 1905–1923 dry and siliceous ores yielded 65.6 per cent of the total output of gold, placer mining 25.3 per cent, copper ore 6.6 per cent, and all other ores 2.5 per cent. It is evident that there can be no great increase from the miscellaneous ores. The yield from copper ore may increase, but no probable gain will bring the output of gold from copper ore to more than $6,000,000 or $7,000,000. The yield of gold from placers in 1923 was less than half that of the average of the years 1906–1916, and though there may be spasmodic increases during the next few years, it is practically certain that the output from this source will decline, owing to the steady exhaustion of ground capable of being worked with dredges. Apparently any large increases in the yield of gold must come from dry and siliceous ores, which have yielded two-thirds of the output in the last 19 years. As the production from these ores has decreased more than 50 per cent since 1915, as no new large bodies of ore of that class have been discovered, and as some of the low-grade siliceous ore can not be worked on account of the increased cost of mining and milling, there is apparently no reason to expect that the annual yield of gold from mines in the United States will exceed $50,000,000 to $55,000,000.

Gold produced in the United States, by sources, as reported by mines, 1914–1923, in fine ounces [a]

Year	Placers	Dry and siliceous ores	Copper ore	Lead ore	Zinc ore	Copper-lead and copper-lead-zinc ores	Lead-zinc ore	Total
1914	1,117,931	2,940,873	264,832	74,514	1,913	548	17,451	4,418,062
1915	1,077,432	3,212,298	343,226	84,449	4,975	2,496	29,599	4,754,475
1916	1,106,901	2,795,764	401,127	71,922	8,302	4,452	28,539	4,417,007
1917	1,026,062	2,416,985	341,117	68,464	6,085	4,474	37,022	3,900,209
1918	758,202	2,045,495	309,018	55,246	1,188	1,431	42,093	3,212,673
1919	704,377	1,780,567	186,701	41,945	86	1,043	38,563	2,753,282
1920	603,002	1,523,331	171,055	46,776	3,657	3,731	31,435	2,382,987
1921	677,435	1,548,251	52,765	61,924	76	159	4,400	2,345,010
1922	537,910	1,560,789	130,928	35,415	2,807	2,467	22,935	2,293,251
1923	551,929	1,510,098	271,690	38,109	3,321	3,801	25,965	2,404,913

[a] Philippine Islands and Porto Rico excluded.

PLACERS

GENERAL FEATURES

The States showing a considerable increase in placer gold in 1923 were California (49,474 ounces), Idaho (15,225 ounces) and Colorado (388 ounces). The largest decreases were in Alaska (38,047 ounces), Nevada (7,660 ounces), Oregon (3,356 ounces), and Montana (1,500 ounces).

The placer gold is derived chiefly from dredging (which yielded 79 per cent of the total in 1923), from drift mining (which is of decreasing importance in Alaska in frozen ground at no great depth but of continued importance in California in ancient buried river channels, in places at considerable depth), and from hydraulic and sluicing placers. Finally, there is a small annual output of gold from dry placers in the Southwest and also of gold and platinum from ocean-beach mining in California and Oregon.

Some interesting notes on beach mining in California and Oregon and on dry placers in California, by Charles G. Yale, and on dry

placers in Arizona, Nevada, and New Mexico, by V. C. Heikes, were published in Mineral Resources for 1912.

DREDGING

The value of gold produced by dredging in the United States from the commercial beginning of the industry in 1896 to the end of 1923 has amounted, according to the best available data, to $189,852,493, of which $136,064,934 came from California, $26,723,801 from Alaska, $9,592,435 from Montana, $7,371,960 from Colorado, $5,068,287 from Idaho, $4,430,971 from Oregon, and $600,105 from other States. The production of gold from dredges in 1923 was much more than in 1922, though the number of dredges operated was five less than in 1922. Further information, especially for earlier years, is to be found in previous issues of Mineral Resources, in reports of the Director of the Mint, and in reports of geological surveys or mining officials of different States.

Gold produced in the United States by dredges, 1914–1923

Year	Dredges	California	Alaska	All other States [a]	Total
1914	120	$7,783,394	$2,350,000	$2,379,389	$12,512,783
1915	114	7,796,465	2,330,000	2,356,660	12,483,125
1916	113	7,769,227	2,679,000	2,338,487	12,786,714
1917	109	8,313,527	2,500,000	1,736,898	12,550,425
1918	93	7,431,927	1,425,000	1,485,173	10,342,100
1919	91	7,716,919	1,360,000	1,269,297	10,346,216
1920	78	6,900,366	1,129,932	1,256,158	9,286,456
1921	72	7,756,787	1,582,520	1,196,261	10,535,568
1922	71	4,999,215	1,767,753	922,300	7,689,268
1923	66	6,065,735	1,848,596	1,084,716	8,999,047

[a] Colorado, Idaho, Montana, Oregon, New Mexico, Nevada, South Dakota, Wyoming, Washington, Alabama, Georgia, and North Carolina.

Of the output in 1923 California produced $6,065,735 from 29 dredges, Alaska $1,848,596 from 25 dredges, Colorado $358,864 from 4 dredges, Idaho $469,900 from 4 dredges, Oregon $224,117 from 3 dredges, and Nevada $31,835 from 1 dredge.

DRY AND SILICEOUS ORES

The siliceous ore comprises free-milling (amalgamating) ore, as in Alaska, California, Arizona, and Oregon; both amalgamating and concentrating ore, as in many States; simply concentrating ore, as in parts of Colorado and Arizona; all-sliming and cyaniding ore; and finally smelting ore. Tailings both from old dumps and from present millings are largely reworked by concentration and subsequent cyanidation. Owing to the increase in the cost of labor and supplies in the last five or six years, much of the old tailings could not be reworked at a profit.

The material smelted consists mainly of concentrates and of siliceous and pyritic ores, which are also valuable as fluxes. Exact figures of relative output by methods and by States are given in another table.

As most of the gold produced in the United States is derived from placer gravel and dry and siliceous ores, including true gold, gold-silver, and silver ores, the following table for certain States, prepared by V. C. Heikes, is of special interest:

Gold produced in six Western States in 1919–1923

Year	Number of producers	Ore mined (short tons)	Total gold, including placer production (fine ounces)	Gold ore			
				Number of producers	Short tons	Gold content (fine ounces)	
						Total	Average
Arizona:							
1919	339	13,727,403	217,997.72	34	190,069	125,188.13	0.66
1920	318	14,920,478	231,528.65	41	201,334	139,857.94	.69
1921	215	5,455,030	141,753.41	26	182,194	114,044.05	.63
1922	318	10,746,045	170,479.98	72	173,070	102,814.10	.59
1923	341	17,015,178	296,109.23	65	226,585	142,442.85	.63
Idaho:							
1919	210	1,457,395	34,502.89	31	44,537	21,989.06	.49
1920	163	1,958,401	23,490.42	17	38,534	13,708.33	.35
1921	225	1,514,447	26,399.73	29	47,174	13,710.44	.29
1922	248	1,436,884	24,255.46	36	21,580	8,734.16	.40
1923	231	1,763,520	37,124.28	47	21,953	6,247.99	.28
Montana:							
1919	457	4,183,594	107,856.32	87	130,922	56,301.56	.43
1920	457	5,241,615	89,550.11	60	98,307	38,284.51	.39
1921	445	1,324,801	71,631.91	104	96,504	41,684.11	.43
1922	393	4,385,878	80,145.62	77	161,900	42,695.72	.26
1923	382	5,743,535	85,079.43	78	217,307	48,277.86	.22
Nevada:							
1919	421	3,187,831	219,695.16	94	163,279	111,170.33	.68
1920	473	3,480,620	172,540.46	106	102,772	48,873.75	.48
1921	431	1,096,138	160,254.62	122	63,850	50,699.95	.79
1922	387	1,565,276	159,510.95	108	69,337	57,954.24	.84
1923	389	4,354,937	204,292.89	128	142,148	64,197.59	.45
Utah:							
1919	179	6,745,423	104,464.41	6	553	1,528.81	2.76
1920	164	6,800,180	97,454.15	3	19	85.00	4.47
1921	138	2,137,522	85,619.15	2	69	266.69	3.86
1922	154	5,560,034	111,110.36	4	36,624	15,924.48	.43
1923	150	12,752,998	148,824.86	9	17,903	9,333.57	.52
Washington:							
1919	49	100,879	12,232.20	11	25,648	11,951.91	.46
1920	44	85,318	5,846.60	10	12,513	5,510.88	.44
1921	37	22,885	6,215.51	9	15,985	5,966.77	.37
1922	46	36,046	9,044.43	10	17,944	8,764.15	.49
1923	36	56,900	16,547.49	12	30,146	16,310.46	.54

Year	Gold-silver ore		Silver ore		Placers	
	Short tons	Gold (fine ounces)	Short tons	Gold (fine ounces)	Number of producers	Gold (fine ounces)
Arizona:						
1919	19,536	6,474.19	85,070	4,279.51	15	227.07
1920	1,177	236.75	78,190	9,423.34	8	220.93
1921	75	23.67	50,932	2,390.05	37	605.85
1922	2,031	1,351.19	71,185	4,249.82	33	579.58
1923	268,537	35,273.99	71,171	6,742.02	24	428.31
Idaho:						
1919	21	15.94	3,693	257.08	72	9,227.63
1920	5	9.55	1,272	88.49	49	5,505.76
1921	54	39.14	993	76.96	92	8,784.90
1922	257	193.81	3,929	156.97	94	8,899.64
1923	311	82.91	1,795	239.24	85	24,125.05
Montana:						
1919	118	61.58	90,646	7,926.41	62	14,097.92
1920	847	423.20	79,198	6,585.71	65	13,977.76
1921	1,401	715.66	67,001	4,978.18	97	10,988.91
1922	6,594	1,079.35	204,817	9,568.17	78	3,472.65
1923	275	394.11	124,671	6,071.84	78	1,972.68
Nevada:						
1919	68,874	28,478.76	551,414	54,358.94	37	6,399.43
1920	76,863	24,216.14	619,572	62,968.62	39	7,383.91
1921	60,365	18,969.68	543,345	63,625.31	61	17,566.99
1922	44,503	10,189.16	758,043	72,362.96	42	11,602.36
1923	551,504	39,417.45	678,318	63,579.46	35	3,941.83
Utah:						
1919	14,618	3,489.71	224,517	20,198.11	----	----
1920	24,837	10,209.30	266,164	23,053.69	3	21.91
1921	33,616	11,769.97	342,787	17,517.44	4	20.03
1922	4,145	2,178.47	373,570	20,250.67	7	103.04
1923	23,732	3,095.32	304,800	20,285.62	4	25.49
Washington:						
1919	----	----	3,438	65.02	7	60.32
1920	----	----	583	38.94	9	71.20
1921	----	----	4,214	48.61	11	148.66
1922	----	----	6,838	66.72	13	162.44
1923	----	----	3,353	38.46	6	73.09

Nearly all the siliceous ore in three of the largest gold-producing States—Alaska, California, and South Dakota—yields only a small quantity of silver and is classed as gold ore. The siliceous ore from Colorado includes some silver and gold-silver ores, but the great bulk of the siliceous ore is purely gold ore.

Siliceous ore treated and gold recovered per ton of ore treated in 1914–1923

Year	Alaska		California		South Dakota		Colorado	
	Ore treated	Recovery per ton	Ore treated	Recovery per ton	Ore treated	Recovery per ton	Ore treated	Recovery per ton
	Short tons	*Ounce*	*Short tons*	*Ounce*	*Short tons*	*Ounce*	*Short tons*	*Ounce*
1914	1,738,127	0.135	2,050,797	0.264	2,019,255	0.175	2,157,762	0.414
1915	3,020,607	.097	2,368,352	.272	1,889,970	.189	2,183,431	.464
1916	3,548,798	.081	2,192,078	.262	1,870,721	.193	2,057,452	.412
1917	3,414,664	.065	2,018,003	.246	1,867,859	.191	1,996,590	.347
1918	2,095,577	.080	1,538,960	.261	1,781,569	.178	1,760,222	.322
1919	3,262,573	.068	1,212,142	.339	1,330,349	.177	1,667,076	.258
1920	3,413,736	.063	788,136	.439	1,356,098	.167	1,224,081	.257
1921	2,894,813	.064	902,566	.402	1,725,669	.185	1,230,172	.250
1922	2,513,455	.058	1,052,148	.414	1,751,454	.180	1,296,501	.221
1923	2,502,901	.045	925,659	.347	1,665,439	.186	1,166,470	.243

The quantity of siliceous ore treated in South Dakota in 1923 decreased, but the recovery of gold per ton was slightly larger; the siliceous ore in California decreased 126,489 tons and the gold recovery per ton was the smallest recorded since 1919.

COPPER ORE

The gold obtained as a by-product in the smelting of copper ore sold or treated in 1923 showed a large increase in quantity and a very large increase in percentage of the total gold yield. The largest producer was Arizona, followed by Utah, Nevada, Montana, New Mexico, and California.

LEAD ORE

The gold in lead ores sold or treated in 1923 came chiefly from Utah, Arizona, Colorado, Nevada, Montana, and Idaho and showed an increase compared with the output in 1922.

LEAD-ZINC, ZINC, AND MIXED ORES

The production of gold from zinc, lead-zinc, copper-lead, and copper-lead-zinc ores in 1923 was about 4,877 ounces more than in 1922. Colorado and Utah produced nearly all the gold from lead-zinc ore, and Montana produced most of the gold from zinc ore. Idaho and Nevada contributed nearly all the gold from copper-lead ore.

MINE PRODUCTION OF SILVER, BY SOURCES

The mine production of silver in 1923 from the three chief sources—dry and siliceous ores, copper ore, and lead ore—was 88.78 per cent of the total, against 91.11 per cent in 1922. The combined yield of silver from placer bullion, zinc ore, and copper-lead ore was only 5.08 per cent of the total.

Mine production of silver in the United States in 1923, by States, in fine ounces [a]

State	Placers	Dry and siliceous ores	Copper ore	Lead ore	Zinc ore	Copper-lead and copper-lead-zinc ores	Lead-zinc ore	Total
Alabama and Georgia	3							3
Alaska	22,372	57,763	715,040	13,374		6,100		814,649
Arizona	72	1,968,675	4,269,278	1,690,534		15,183		7,343,742
California	20,305	2,845,764	360,345	330,241		2,788		3,559,443
Colorado	4,122	3,954,324	110,552	625,974	51,217	16,680	571,619	5,334,488
Idaho	6,616	67,294	74,247	5,489,477		917,215	1,118,813	7,673,662
Illinois [b]				8,170				8,170
Michigan			223,997					223,997
Missouri				177,270				177,270
Montana	360	1,280,235	7,619,864	437,703	2,119,593	340,559	1,582,548	13,380,862
Nevada	1,783	9,084,056	84,568	1,238,842	320	13,089	191,906	10,614,564
New Mexico	30	544,607	164,699	34,815		2,976		747,127
North Carolina and South Carolina	1	4	74					79
Oregon	2,062	71,749	22,511					96,322
Pennsylvania [c]			3,005					3,005
South Dakota		95,844						95,844
Tennessee			105,712					105,712
Texas		802,303	1,764	7,757				811,824
Utah	3	6,737,300	867,618	10,648,952	56	30,924	852,617	19,137,470
Washington	23	127,029	60,805	36,819		2,511		227,187
Wyoming			254					254
	57,752	27,636,947	14,684,333	20,139,928	2,171,186	1,348,025	4,317,503	70,355,674
Value	$47,357	$22,662,296	$12,041,153	$16,514,741	$1,780,372	$1,105,380	$3,540,352	$57,691,651
Percentage	0.08	39.28	20.87	28.63	3.08	1.92	6.14	100.00
1922: Total	60,769	28,631,579	10,376,123	16,756,835	1,676,967	669,809	3,035,907	61,207,989
Value	$60,769	$28,631,579	$10,376,123	$16,756,835	$1,676,967	$669,809	$3,035,907	$61,207,989
Percentage	0.10	46.78	16.95	27.38	2.74	1.09	4.96	100.00

[a] Philippine Islands and Porto Rico excluded.
[b] From fluorspar-lead ore.
[c] From pyritiferous magnetite ore.

The production of silver as reported by the mines had increased pretty steadily from 1908 to 1916. A decline during the next three years was followed by partial recovery in 1920, another decline in 1921, a large increase in 1922, and a considerable increase in 1923. The combined production of silver from lead and lead-zinc ores increased from 19,792,742 ounces in 1922 to 24,457,431 ounces in 1923.

Silver produced in the United States, by sources, as reported by mines, 1914–1923, in fine ounces

Year	Placers	Dry and siliceous ores	Copper ore	Lead ore	Zinc ore	Copper-lead and copper-lead-zinc ores	Lead-zinc ore	Total
1914	152,128	27,812,335	14,829,828	19,302,081	145,264	248,866	7,132,747	69,623,249
1915	154,968	25,709,505	18,781,365	19,828,533	1,136,220	234,047	6,509,092	72,353,730
1916	126,351	24,593,656	24,541,234	19,216,586	1,274,292	533,273	8,572,141	78,857,533
1917	118,604	21,489,465	20,314,233	19,096,474	549,656	448,042	8,645,038	70,661,512
1918	89,494	21,564,982	20,462,597	18,291,243	135,676	224,580	7,290,380	68,058,952
1919	78,401	19,043,515	12,880,624	14,351,293	39,480	232,157	5,273,990	51,899,460
1920	73,383	20,477,612	12,151,424	17,069,506	1,258,341	669,503	4,837,135	56,536,904
1921	81,375	24,117,251	4,782,538	14,912,990	6,163	449,417	1,983,222	46,332,956
1922	60,769	28,631,579	10,376,123	16,756,835	1,676,967	669,809	3,035,907	61,207,989
1923	57,752	27,636,947	14,684,333	20,139,928	2,171,186	1,348,025	4,317,503	70,355,674

PLACERS

The output of silver from the refining of placer gold in 1923 was 3,017 ounces less than in 1922. Of the total production about 74 per cent came from Alaska and California.

DRY AND SILICEOUS ORES

About 33 per cent of the mine production of silver from dry and siliceous ores in 1923 came from Nevada (chiefly from the Tonopah district), 24 per cent from Utah (mainly from the Tintic district), and more than 14 per cent from Colorado. There were increases in the quantity of silver from siliceous ore in some States, especially in Nevada, Arizona, California, and Texas.

A large part of the silver from gold-silver siliceous ore is obtained with the gold by amalgamation and cyanidation in the mills, and the silver is then recovered by refining the mill bullion. The remainder is produced by smelting the richer ore and refining the copper or lead bullion produced.

COPPER ORE

The silver produced from copper ore is obtained in the electrolytic refining of Lake and blister copper produced by smelting. The copper ore consists mainly of sulphides (except the Lake ore of Michigan, which consists of native metal in amygdaloid and conglomerate matrix), and a greater quantity contains chalcocite than chalcopyrite or cupriferous pyrite. The silver tenor of the extensive disseminated deposits of the Santa Rita district, N. Mex., and of Ely, Nev., is notably low, but similar deposits elsewhere add considerable quantities of silver.

In output of silver from copper ore Montana continued to lead, with a yield of 7,619,864 ounces in 1923, against 5,446,684 ounces in 1922. Arizona was next, with 4,269,278 ounces in 1923, against 2,766,277 ounces in 1922. The production of Montana comes mainly from Butte, that of Arizona chiefly from Bisbee and Jerome, that of Utah from Tintic and Bingham, and that of California from Plumas County. Of these districts, Bisbee well represents the disseminated type, Bingham produces from both lode and disseminated deposits, and the remainder produce silver chiefly from copper ore mined from deep lodes. Some silver is also produced in leaching copper ore.

LEAD ORE

The mine production of silver from argentiferous lead ore increased considerably in 1923. The output from Idaho increased 39,439 ounces, that of Nevada 540,252 ounces, that of Arizona 345,975 ounces, that of Utah 2,465,211 ounces, and that of Colorado 132,277 ounces; that of Montana decreased 210,051 ounces. The yield of Idaho is derived mainly from the silver-lead ore of the Coeur d'Alene district, that in Utah chiefly from the Park City and Tintic districts, and that in Colorado from Aspen and Leadville. The production of silver from lead ore increased also in Alaska, California, New Mexico, Texas, and Washington. Most of the output is obtained from the desilverization of lead bullion from smelting of western ores and concentrates.

ZINC, LEAD-ZINC, AND MIXED ORES

Silver from argentiferous zinc ore increased nearly 500,000 fine ounces in 1923. The output was mainly a refinery by-product from the smelting of zinc concentrates from Montana and Colorado.

Silver from lead-zinc ore increased nearly 1,282,000 ounces; it came chiefly from Montana, Idaho, and Utah. The output of silver from copper-lead and copper-lead-zinc ores came mainly from Idaho and Montana.

DISTRIBUTION OF PRODUCTION OF GOLD AND SILVER, BY METHODS OF TREATMENT

SUMMARY OF DISTRIBUTION

In the following table is given the recoverable gold and silver content of the ore, tailings, and slag treated in 1923.

Distribution of gold and silver produced in the United States in 1923, by States [a]

State or Territory	Total quantity of crude ore, tailings, and slag treated or sold in 1923 (short tons)	Ore to gold and silver mills			Crude ore to concentrating mills (short tons)	Concentrates from all sources		
		Short tons	Gold in bullion (fine ounces)	Silver in bullion (fine ounces)		Short tons	Gold (fine ounces)	Silver (fine ounces)
Alaska	3,234,192	2,502,901	97,325	20,645	686,532	67,800	15,950	457,498
Arizona	17,015,178	229,872	142,798	247,601	12,037,653	782,357	17,554	1,116,891
California	1,535,691	740,319	274,800	119,089	715,282	67,602	51,558	2,553,564
Colorado	1,569,100	817,328	221,022	44,257	549,522	150,566	62,781	3,222,670
Idaho	1,763,520	21,901	5,987	1,822	1,573,011	263,785	4,457	5,963,742
Montana	5,743,535	193,633	[b] 38,174	[b] 100,526	4,055,998	1,505,482	30,989	11,672,719
Nevada	4,354,937	1,226,565	[c] 156,684	[c] 8,396,727	2,823,507	298,678	29,344	1,134,192
New Mexico	3,111,050	50,940	9,598	328,161	2,918,384	154,760	5,291	105,012
Oregon	50,385	27,006	5,887	14,589	19,705	5,450	3,520	23,622
South Dakota	1,665,439	1,665,424	309,868	95,759				
Texas	78,610	78,322		799,847				
Utah	12,752,998	14,318	2,884	38,290	11,968,951	750,631	99,668	3,347,890
Washington	56,900	5,640	2,904	166	18,851	2,242	110	59,133
Wyoming	584							
Eastern States	[d] 1,763,276	46	21	4	1,263,061	46,501	240	41,505
	54,695,395	7,574,215	1,267,952	10,207,483	38,630,457	4,095,854	321,462	29,698,438
Total, 1922	34,484,845	7,341,840	1,332,645	8,980,812	20,995,414	2,346,449	237,499	22,543,927

State or Territory	Crude ore to smelters			Ore leached and old slag and tailing treated		
	Short tons	Gold (fine ounces)	Silver (fine ounces)	Short tons	Gold (fine ounces)	Silver (fine ounces)
Alaska	44,759	1,703	314,134			
Arizona	2,919,177	135,312	5,972,105	1,828,476	17	7,073
California	51,349	4,608	836,725	28,741	714	29,760
Colorado	202,250	17,438	2,063,439			
Idaho	99,626	2,555	1,693,501	68,982		7,981
Montana	179,389	13,611	1,507,069	1,314,515	333	100,188
Nevada	202,041	7,103	657,360	102,824	7,220	424,502
New Mexico	141,726	11,596	313,924			
Oregon	3,645	1,181	56,048	29	115	1
South Dakota	15	37	85			
Texas	288	39	11,977			
Utah	588,008	45,584	14,561,434	181,721	663	1,189,853
Washington	32,409	13,460	167,865			
Wyoming	584	14	254			
Eastern States	500,169	266	67,286			
	4,965,435	254,507	28,223,206	3,525,288	9,062	1,759,358
Total, 1922	3,378,642	180,733	27,131,989	2,768,949	4,464	1,894,821

[a] Exclusive of silver from copper ore in Michigan and from lead and lead-fluorspar ore in Illinois and Missouri, of gold and silver from siliceous ore in Philippine Islands, and of gold and silver from Porto Rico.

[b] Includes residues from 20,730 tons of old tailings.

[c] Includesresidues from 44,792 tons of old tailings.

[d] Includes low-grade pyritiferous magnetite ore from Pennsylvania.

The greatest output was made in Arizona, Utah, and Montana, all notable for large yields of copper ore; in Idaho, a large producer of lead ore and siliceous ore; in Alaska, California, and Nevada, large producers of both copper and siliceous ores; in South Dakota and Colorado, large producers of siliceous ore; and in New Mexico, a large producer of copper ore.

Many gold and silver mills employ concentrating apparatus, and the concentrates they obtain are combined in the table with those from straight concentrating mills under the heading "Concentrates from all sources." The gold and silver included in this item are recovered partly by amalgamation and cyanidation.

The figures for the quantity of ore treated by concentration include the large quantities of copper, lead, zinc, and mixed ores whose concentrates are smelted primarily for these metals, the gold and silver being recovered in refining the copper and lead bullion and smelting the zinc residues. Examples are the copper ore of the disseminated deposits of Bingham, Utah, and of New Mexico and Nevada; the copper ore of Butte, Mont., and Ely, Nev.; and the lead and lead-zinc ores of Coeur d'Alene, Idaho, Butte, Mont., and Leadville, Colo. The quantity of concentrates produced and the recoverable gold and silver content represent not only the concentrates from these straight concentrating mills but also the small quantity from gold and silver mills.

The ore treated in straight concentration mills increased more than 80 per cent in 1923, mainly because of more activity at copper mines in Arizona, Montana, Nevada, Utah, Alaska, and other States. About 60 per cent of the recoverable silver from concentrates produced came from Montana and Idaho, and large quantities came from Utah, Colorado, and California.

The figures for the quantity and the recoverable precious-metal content of crude ore shipped from the mines direct to the smelters in general include the richer gold, silver, copper, lead, and mixed ores from which the gold and silver is eventually recovered by refining the copper or lead bullion that collects the precious metals in the smelting. Arizona produced nearly 60 per cent of the ore directly smelted, and Utah and Arizona produced 73 per cent of the silver recovered from crude ore smelted.

The old materials, principally tailings and slags, re-treated (with which are included ore and tailings leached) are partly smelted, often for their fluxing as well as their metal value; but considerable quantities of old tailings are now concentrated and cyanided, and the impounding of mill tailings for future treatment as well as because of legal requirements has become a general practice. Owing to the higher price of base metals, more old slag and tailings was treated in 1923 than in 1922. Most of the gold and silver derived from the old tailings is included under recoveries by amalgamation and cyanidation at gold and silver mills. The total quantity of ore leached in 1923 was 1,951,447 short tons, of which 1,812,685 tons came from Arizona and 88,612 tons from Utah. The ore and old tailings leached in 1922 amounted to 1,478,952 tons.

Gold and silver produced at mills in the United States and percentage of gold and silver recovered by smelting and from placers, 1914–1923 [a]

Year	Ore and tailings treated (short tons)	Bullion recovered (fine ounces)					
		Amalgamation		Cyanidation		Chlorination	
		Gold	Silver	Gold	Silver	Gold	Silver
1914	9,849,085	924,253	271,417	1,384,935	15,399,836	23,488	2,530
1915	11,878,287	1,084,034	382,459	1,444,077	16,184,924	25,081	3,749
1916	11,393,838	964,589	348,177	1,260,172	14,432,378	20,346	2,784
1917	11,076,211	828,681	288,791	1,169,478	11,535,747	9,102	283
1918	8,524,496	678,359	216,670	1,047,186	9,736,605	5,770	3,631
1919	8,668,507	839,761	279,793	685,330	7,163,726	----	----
1920	7,560,043	679,409	228,807	580,205	7,582,358	----	----
1921	7,429,125	765,397	207,877	559,352	7,414,275	----	----
1922	7,442,998	812,396	183,119	541,318	8,803,787	----	----
1923	7,657,613	683,274	179,527	607,415	10,044,388	----	----

Year	Percentage of gold and silver from all sources									
	Amalgamation		Cyanidation		Chlorination		Placers		Smelting [b]	
	Gold	Silver	Gold	Silver	Gold	Silver	Gold	Silver	Gold	Silver
1914	20.9	0.4	31.4	22.1	0.4	----	25.2	0.2	22.1	77.3
1915	22.8	.4	30.4	22.1	.5	----	22.7	.2	23.6	77.3
1916	21.5	.4	28.1	18.3	.5	----	25.0	.2	24.9	81.1
1917	20.9	.4	29.5	16.3	.2	----	25.8	.2	23.6	83.1
1918	20.7	.3	32.0	14.3	.2	----	23.6	.13	23.5	85.3
1919	31.5	.5	28.5	13.8	----	----	25.6	.15	14.4	85.5
1920	28.5	.4	24.3	13.4	----	----	25.3	.13	21.9	86.1
1921	32.6	.45	23.9	16.0	----	----	28.9	.18	14.6	83.4
1922	35.4	.3	23.6	14.4	----	----	23.5	.1	17.5	85.2
1923	28.4	.3	25.3	14.3	----	----	22.9	.1	23.4	85.3

[a] Philippine Islands and Porto Rico excluded. [b] Both crude ores and concentrates.

The dredges produced $1,309,779 more gold in 1923 than in 1922, and the combined placer yield from hydraulic, drift, and other surface mines was $1,019,974 less than in 1922. The percentage of the output of silver credited to the placers is insignificant.

Arizona, Nevada, Colorado, and South Dakota ores yielded the larger part of the gold recovered by cyanidation, and the increase was due to larger recoveries by the cyanide process in Arizona, California, Nevada, and Montana. The chlorination process has not been used in California since 1918.

GOLD AND SILVER PRODUCED AT MILLS, BY STATES

A large quantity of concentrates from sulphide ores is now smelted, and the increased application of the flotation process has resulted in decreased yield of gold and silver from cyanidation, as nearly all such concentrates are shipped to smelters.

The smelters, which had for two years been producing a slightly less proportion of gold and silver, are to be credited in 1923 with 23.4 per cent of the total output of gold and 85.3 per cent of the silver.

The bulk of the gold produced continues to come from the gold mills. As shown in the table, the proportion of gold recovered by amalgamation and cyanidation has increased from 49.6 per cent in 1916 to 53.7 per cent in 1923.

Gold and silver bullion produced at mills in 1923, by States [a]

State	Ore and tailings treated (short tons)	Bullion recovered (fine ounces)				Percentage of gold and silver from all sources in State			
		Amalgamation		Cyanidation		Amalgamation		Cyanidation	
		Gold	Silver	Gold	Silver	Gold	Silver	Gold	Silver
Alaska	2,502,901	97,160	20,463	165	182	33.6	2.5	0.06	0.02
Arizona	244,219	772	306	142,026	247,295	.26	-------	48.0	3.4
California	743,819	234,939	57,538	[b] 62,483	[b] 77,982	36.3	1.6	9.7	2.2
Colorado [c]	817,328	96,805	25,344	124,217	18,913	30.4	.5	39.0	.35
Idaho	21,901	5,440	1,633	547	189	14.7	.02	1.5	-------
Montana	214,363	6,906	1,430	31,268	99,096	8.1	.01	36.8	.7
Nevada	1,271,357	17,615	10,776	139,069	8,385,951	8.6	.1	68.1	79.0
New Mexico	50,940	2,647	434	6,951	327,727	9.9	.06	26.0	43.9
Oregon	27,035	1,151	796	4,851	13,794	4.8	.8	20.1	14.3
South Dakota [d]	1,665,424	216,907	60,624	92,961	35,135	69.99	63.25	30.00	36.66
Texas	78,322	-------	-------	-------	799,847	-------	-------	-------	98.5
Utah	14,318	12	16	2,872	38,274	-------	-------	1.9	.2
Washington	5,640	2,899	163	5	3	17.5	.07	.03	-------
Eastern States	46	21	4	-------	-------	3.6	-------	-------	-------
	7,657,613	683,274	179,527	607,415	10,044,388	28.4	.3	25.3	14.3
Value	-------	$14,124,527	$147,212	$12,556,382	$8,236,398	-------	-------	-------	-------
1922: Total	7,442,998	812,396	183,119	541,318	8,803,787	35.4	.3	23.6	14.4
Value	-------	$16,793,716	$183,119	$11,190,036	$8,803,787	-------	-------	-------	-------

[a] Philippine Islands and Porto Rico excluded.
[b] Includes gold and silver from 9,039 tons of concentrates cyanided.
[c] Also 230,717 tons of sands and slimes from ore first treated by amalgamation.
[d] Also 1,626,234 tons of sands and slimes from 1,652,337 tons of ore amalgamated was cyanided.

The great bulk of the ore treated was milled in Alaska, South Dakota, Nevada, Colorado, California, and Arizona, and here the famous mines and mills of the Homestake, Mother Lode, Grass Valley, Treadwell, Cripple Creek, Tonopah, Goldfield, and San Francisco (Oatman) districts are especially noteworthy. Large numbers of smaller mills, however, mark the wide distribution of gold mining in these regions and in many other scattered districts.

The total yield of gold by amalgamation in the United States in 1923 was 437,070 ounces less than in 1911. Appreciable increases in 1923 were shown in Colorado, Montana, and Nevada, and there were decreases in Alaska, California, Idaho, New Mexico, South Dakota, and Washington.

The output of gold by cyanidation was 66,097 ounces more than in 1922. There were increases in Arizona, California, Nevada, Montana, Oregon, and New Mexico. The principal decreases were in Alaska, 15,745 ounces; Utah, 5,958 ounces; and South Dakota, 4,001 ounces.

Nevada led in yield of silver by cyanidation, and the most notable gains were in Nevada, 937,938 ounces; Texas, 157,412 ounces; Arizona, 95,458 ounces; and New Mexico, 66,119 ounces.

Of the gold-producing States whose output is derived chiefly from milling ores, Alaska, California, Idaho, South Dakota, and Washington still yield more gold by amalgamation than by cyanidation, but cyanidation produces more gold than amalgamation in Arizona, Colorado, Montana, Nevada, New Mexico, Oregon, and Utah, and it produces much more silver in Arizona, Montana, Nevada, New Mexico, Texas, and Utah. Only in Alaska, Colorado, Idaho, South Dakota, and Washington did the recovery of silver by amalgamation

exceed that by cyanidation. Altogether amalgamation produced gold and silver valued at $14,271,739 from milling ores in 1923, against $20,792,780 produced by cyanidation.

QUICKSILVER AND POTASSIUM AND SODIUM CYANIDE CONSUMED IN CERTAIN STATES

For details of the consumption of quicksilver in the amalgamation milling process and of potassium cyanide and sodium cyanide in the cyanidation process the reader is referred to the mine reports for the several Western States. The consumption of quicksilver at mills treating ore, in dredging, and in other methods of placer mining is given in the separate chapters on quicksilver in Mineral Resources for 1917–1919.

The following tables were compiled by V. C. Heikes:

Quicksilver purchased or consumed at mills in five Western States, 1919–1923

State and year	Number of mills using quicksilver	Ore and tailings treated (short tons)	Quicksilver consumed (pounds)[a]	
			Total	Per ounce of gold and silver bullion
Arizona:				
1919	6	2,374	33	0.077
1920	4	1,688	56	.031
1921	9	1,215	68	.066
1922	17	2,375	48	.052
1923	12	1,567	107	.099
Idaho::				
1919	12	40,504	828	.0406
1920	9	38,556	737	.053
1921	14	44,545	355	.025
1922	13	21,523	411	.042
1923	20	21,117	250	.035
Montana:				
1919	17	13,142	178	.054
1920	11	27,989	250	.046
1921	13	2,562	47	.0225
1922	9	43,757	218	.025
1923	14	62,460	385	.046
Nevada:				
1919	21	60,038	1,149	.026
1920	21	41,700	631	.021
1921	23	13,143	224	.009
1922	22	10,875	522	.021
1923	27	25,354	690	.024
Washington:				
1921	3	2,930	227	.126
1922	1	8,886	75	.015
1923	2	5,628		

[a] Partly estimated.

Quicksilver consumed at mills in Colorado in 1923 amounted to 4,290 pounds, in New Mexico to 250 pounds, and in South Dakota to 10,725 pounds.

Dredges in California used about 8,400 pounds of quicksilver in 1923. The quicksilver used by other placers and at deep mines is estimated at 8,000 pounds, making a total of more than 16,000 pounds for California.

Sodium cyanide consumed at mills in certain Western States, 1917–1923, in pounds [a]

State	1917	1918	1919	1920	1921	1922	1923
Arizona	157,381	157,204	99,605	219,569	293,597	259,506	330,666
Colorado	746,428	779,741	582,547	338,763	360,000	301,794	309,565
Idaho	3,728	15,600	950	1,600	11,391	4,701	3,900
Montana	158,215	83,542	64,900	105,874	108,665	291,910	274,218
Nevada	1,925,038	1,765,010	992,840	1,672,190	1,107,530	1,831,592	3,199,634
New Mexico	123,500	79,065	108,805	90,200	80,768	64,544	61,391
South Dakota	384,938	370,218	284,653	[b] 365,095	[b] 672,224	387,683	361,900
Texas	37,000	63,130	38,700	36,976	43,028	74,428	83,804
Utah	37,000	2,700	37,844	40,599	93,200	118,103	43,731
Washington					100		50
	3,573,228	3,316,210	2,210,844	[b] 2,870,866	[b] 2,770,503	3,334,261	4,668,859

[a] The consumption of potassium cyanide was 137,658 pounds in 1917, 625 pounds in 1918, 68,155 pounds in 1919 (17,884 pounds at mills in Arizona and 50,271 pounds at mills in Nevada), 7,825 pounds in 1920 (7,800 pounds at mills in Arizona and 25 pounds at mills in Washington), 5,626 pounds in 1921 (Arizona 4,200 pounds, Idaho 600 pounds, and South Dakota 826 pounds), and 6,610 pounds in 1922 (Arizona 3,550 pounds, Idaho 800 pounds, Montana 1,030 pounds, Nevada 230 pounds, Washington 1,000 pounds). In 1923 Nevada mines used 575 pounds.

[b] Includes some cyanamid in 1920 and 1921, which is reduced to the equivalent of 96 per cent NaCn.

Potassium and sodium cyanide consumed at mills in six Western States, 1919–1923

State and year	Number of mills using cyanidation process	Ore and tailings treated (short tons)	Cyanide consumed (pounds) [a]		
			Total	Per ton of ore and tailings	Per ounce of gold and silver
Arizona:					
1919	8	211,199	117,489	0.56	0.49
1920	4	206,847	227,369	1.10	.85
1921	9	193,414	297,797	1.54	.21
1922	12	188,879	263,056	1.39	1.04
1923	10	242,652	330,666	1.36	.85
Idaho:					
1919	3	907	950	1.05	2.07
1920	1	334	1,600	4.79	2.70
1921	4	2,658	11,991	4.51	2.12
1922	3	139	5,501		1.68
1923	3	784	3,900	4.97	5.30
Montana:					
1919	11	97,802	64,900	.66	.55
1920	8	60,999	105,874	1.74	1.84
1921	12	73,437	108,665	1.48	1.81
1922	14	113,687	292,940	2.58	2.59
1923	10	151,903	274,218	1.80	2.10
Nevada:					
1919	30	614,190	1,043,111	1.70	.18
1920	33	640,690	1,672,190	2.61	.26
1921	19	617,790	1,107,530	1.79	.17
1922	28	833,025	1,831,822	2.20	.24
1923	32	1,246,003	3,200,209	2.57	.375
Utah:					
1919	1	14,571	37,844	2.60	.57
1920	1	23,682	40,599	1.71	.32
1921	1	33,616	93,200	2.77	.74
1922	1	33,247	118,103	3.55	1.25
1923	1	14,301	43,731	3.06	1.06
Washington:					
1920	1	8	25	3.13	1.04
1921	1	30	100	3.33	.19
1922	1	241	1,000	4.15	.34
1923	1	12	50	4.17	6.25

[a] Partly estimated.

It has not been possible to obtain figures showing the total quantity of potassium cyanide and sodium cyanide used in the recovery of gold and silver in the United States in 1923. If the estimated quantities used in California, 375,000 pounds, Alaska, 500 pounds, and Oregon, 50,000 pounds, are added to the 4,669,434 pounds reported to have been used in other Western States, the total consumption was probably about 5,100,000 pounds.

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GOLD AND SILVER IN SOUTH DAKOTA

(MINE REPORT)

By Charles W. Henderson

PRODUCTION

The producing metal mines in South Dakota in 1923 were five deep mines, as compared with three deep mines and three small placers in 1922. The mills of the State treated 1,665,424 tons of ore, which yielded as bullion $6,405,547 in gold and 95,759 fine ounces of silver, valued at $78,522, an average recovery per ton of $3.846 in gold and 0.0575 ounce in silver, as compared with $3.720 in gold and 0.0678 ounce in silver in 1922.

Mine production of gold and silver in South Dakota in 1922 and 1923

	Number of producing mines	Ore (short tons)	Gold		Silver		Total value
			Fine ounces	Value	Fine ounces	Value	
1923	5	1,665,439	309,905.05	$6,406,306	95,844	$78,592	$6,484,898
Decrease from 1922	1	86,015	5,392.94	111,482	22,916	40,168	151,650

Gold and silver bullion produced at mills in South Dakota in 1923

Process	Ore treated	Gold in bullion	Silver in bullion	Quicksilver used	Sodium cyanide used
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Amalgamation	1,652,337	216,907.61	60,624	10,725	
Cyanidation	[a] 1,639,321	92,960.74	35,135		[b] 361,900
		309,868.35	95,759	10,725	[b] 361,900

[a] Includes 1,626,234 tons of sands and slimes from the ore amalgamated and 13,087 tons of ore cyanided.
[b] Equivalent to 96–98 per cent NaCN.

Mine production of gold and silver in South Dakota, 1914–1923 [a]

Year	Gold	Silver		Total value (commercial)
		Fine ounces	Commercial value	
1914	$7,333,508	176,642	$97,683	$7,431,191
1915	7,406,305	199,864	101,331	7,507,636
1916	7,460,644	215,205	141,605	7,602,249
1917	7,364,233	186,765	153,894	7,518,127
1918	6,565,337	159,202	159,202	6,724,539
1919	4,863,040	116,493	130,472	4,993,512
1920	4,676,470	90,795	98,966	4,775,436
1921	6,605,167	112,464	112,464	6,717,631
1922	6,517,788	118,760	118,760	6,636,548
1923	6,406,306	95,844	78,592	6,484,898

[a] For yearly output to 1913 and authority for each year, see U. S. Geol. Survey Mineral Resources, 1913, pt. 1, p. 42, 1914.

MINING INDUSTRY

Production was continuous in 1923 at the Homestake mine, from which the bulk of the production of South Dakota has come since 1875. The Trojan mill was operated until March 27, 1923. Minor operations are noted in the review by counties.

REVIEW BY COUNTIES

CUSTER COUNTY

The production of placer gold near Custer, which is ordinarily allowed to accumulate in the banks until a sufficient quantity can be marketed, was so small for both 1922 and 1923 that mention of it has been omitted from mine reports for both years.

LAWRENCE COUNTY[1]

Mine production of gold, silver, copper, and lead in Lawrence County, S. Dak., 1916–1923

Year	Number of mines producing	Ore	Gold *	Silver *	Copper	Lead	Total value
		Short tons		*Fine ounces*	*Pounds*	*Pounds*	
1916	29	1,870,572	$7,455,136	215,127	----------	35,406	$7,599,127
1917	24	1,868,143	7,360,266	186,436	736	60,905	7,519,328
1918	13	1,781,661	6,564,850	158,108	2,996	11,536	6,724,517
1919	5	1,329,928	4,863,013	116,010	----------	6,585	4,993,293
1920	7	1,356,189	4,676,470	90,795	----------	12,812	4,776,461
1921	3	1,725,685	6,603,318	112,457	----------	4,000	6,715,955
1922	4	1,751,414	6,515,969	118,753	----------	----------	6,634,722
1923	4	1,665,437	6,406,206	95,844	----------	----------	6,484,798

* Includes both placer and deep mines.

The total value of the product of the Homestake Mining Co. from 1875 to 1923 is $188,419,335.85, and the amount paid in dividends is $45,310,684.29.

Production of the Homestake mine, 1916–1923

Year	Ore milled	Value of product		Dividends
		Total	Per ton	
	Short tons			
1916	1,600,220	$6,531,003.34	$4.0813	$2,210,208
1917	1,677,623	6,619,573.94	3.9458	1,959,048
1918	1,628,630	5,916,890.31	3.6330	1,506,960
1919	1,192,588	4,346,115.79	3.6443	1,130,229
1920	1,274,944	4,410,193.73	3.4591	----------
1921	1,620,588	6,299,780.38	3.8873	502,320
1922	1,663,485	6,285,317.56	3.7784	879,060
1923	1,652,337	6,400,078.42	3.8733	1,506,960

[1] For information on the geology of this county, see Irving, J. D., Ore deposits of the northern Black Hills: U. S. Geol. Survey Bull. 225, pp. 123–140, 1904; Irving, J. D., and Emmons, S. F., Economic resources of the northern Black Hills: U. S. Geol. Survey Prof. Paper 26, pp. 53–212, 1904.

The annual report of the superintendent of the Homestake Mining Co., dated December 31, 1923, says:

Normal production, both as to tonnage milled and bullion recovered, has been maintained during the year just passed.

The South mill has passed from the experimental stage to one of continuous and dependable production.

The third crusher station and skip pocket at the Ellison shaft is now completed, and ore is being hoisted regularly with the electric hoist.

A ventilating fan with a capacity of 225,000 cubic feet of air per minute, which has been installed and connected to the air shaft by a concrete housing, is now in continuous operation. This has very materially improved the air condition throughout the mine. In this connection it should be noted that all drilling machines used underground are of the water type, which eliminates practically all rock dust due to drilling operations.

The addition to the hospital was completed early in the year and was immediately opened for the care of patients.

Eighty-five per cent of the electric power used in operating the mine and treatment plants was generated by water power, indicating an unusually favorable water condition in the northern Black Hills region.

The engineers report as follows: Development drifts driven, 7,915 feet; development raises driven, 2,431 feet; no shaft sinking during the year.

There are 901,549 tons of ore broken down and remaining in the stopes. There are 16,357,168 tons of ore blocked out and remaining in the mine. Developments at the present depth of the mine, which owing to the shortage of labor have been limited during the past few years, indicate that the ore bodies are rapidly diminishing in size. Production should continue during the year 1924 at the same rate as obtained during 1923.

The Homestake mine [2] is developed by four vertical shafts from 800 to 2,370 feet deep and 62 miles of tunnels, drifts, and crosscuts. The amalgamating and cyaniding mills, at Lead, Terraville, Blacktail, and Deadwood, have a total capacity of 4,600 tons a day and consist of five primary mills, the Amicus, Pocahontas, Monroe, South, and Terraville, and four secondary mills, including a regrinding mill, two cyanide sand plants, and one slime plant. The crushing equipment includes 500 stamps weighing 900 pounds each and 120 weighing 1,550 pounds each, 6 Allis-Chalmers rod mills, 8 Allis-Chalmers tube mills, and 1 Hardinge ball mill. There are 25 leaching tanks and 41 thickening tanks.

The Trojan mine was operated until February 10, 1923, and its 400-ton cyanidation mill was operated until March 27, 1923, when a final clean-up was made of the zinc boxes. The ore is siliceous and oxidized and is reached by two shafts 308 and 568 feet deep, eight tunnels aggregating 17,700 feet, and 40,400 feet of drifts. The ore is brought to the mill by a surface tramway three-fourths of a mile long. The mill is equipped with 1 No. 5 K Gates crusher, 2 ball mills, 1 Chile mill, 4 Dorr classifiers, 1 Weigand classifier, 3 Portland filters, 6 leaching tanks, 5 Dorr agitating tanks, and 5 Dorr thickening tanks. This company did development work on a property in the same district 2 miles from the Trojan workings.

Two small lots of gold ore from prospects in Lawrence County were shipped to smelters.

The 100-ton concentration mill of the Gold Feather Gold & Silver Mining Co., on the Monarch group, completed in 1922, was given a trial run during February and March.

[2] For description of geology, see Paige, Sidney, The geology of the Homestake mine; Econ. Geology, vol. 18, pp. 205–237, 1923; Geology of the region around Lead, S. Dak., and its bearing on the Homestake ore body; U. S. Geol. Survey Bull. 765, 1924; U. S. Geol. Survey Geol. Atlas, Central Black Hills folio (No. 219), 1925; Hosted, J. O., and Wright, L. B., Geology of the Homestake ore bodies and the Lead area, South Dakota; Eng. and Min. Jour.-Press, May 5, 1923, pp. 793–799; May 12, 1923, pp. 836–843.

The Cutting Mining Co., which sunk a shaft to 500 feet and did some drifting in 1919–20, started excavations in December, 1923, for a 50-ton flotation mill.

PENNINGTON COUNTY

Trenching on the Doctor No. 2 lode claim, near Redfern, 5 miles from Hill City, produced a small quantity of decomposed rock, from which several ounces of gold was recovered in a rocker.

Shaft and open-cut development late in 1923 on the O. K. group, near Redfern, yielded several tons of ore, from which was recovered in a small amalgamation mill on the property a small quantity of gold bullion, which will be included in the report for 1924. Owing to the lack of a concentrating table, no attempt was made to save the arsenical pyrite which formed a part of the ore treated.

Development work at the North Fork group of claims, near Hill City, uncovered some arsenical pyrite containing gold, silver, and copper.

The Keystone Arsenic Co. took over the old Bullion group and the 40-ton 10-stamp amalgamation and concentration mill at Keystone and placed the property and mill in shape for operations in 1924. The ore contains gold and silver associated with arsenical pyrite.

GOLD, SILVER, AND COPPER IN WYOMING

(MINE REPORT)

By Charles W. Henderson

PRODUCTION

Two cars of copper-gold-silver-palladium-platinum ore from the Electrolytic (Rambler) mine, near Albany; two cars of copper-gold ore from the Williams-Luman (De Pass) mine, near Lysite; and several hundred tons of copper-silver ore from the Sunrise iron mine, at Hartville, constituted the sales of ores mined in Wyoming in 1923.

Mine production of gold, silver, and copper in Wyoming, 1914–1923 [a]

Year	Ore (short tons)	Gold	Silver		Copper		Total value
			Fine ounces	Commercial value	Pounds	Value	
1914	423	$5,006	116	$64	17,421	$2,317	$7,387
1915	4,216	14,592	840	426	447,246	78,268	93,286
1916	8,876	20,566	5,524	3,635	2,610,622	642,213	666,414
1917	6,335	3,762	3,415	2,814	2,027,857	553,605	560,181
1918	2,870	871	965	965	852,777	210,636	212,472
1919	798	84	151	169	139,900	26,021	26,274
1920							
1921	50	62	111	111	10,000	1,290	1,463
1922	24	1,207	57	57	4,296	580	1,844
1923	584	296	254	208	111,280	16,358	16,862

[a] For yearly output, 1842–1914, see U. S. Geol. Survey Mineral Resources, 1914, pt. 1, pp. 248–249, 1916.

REVIEW BY COUNTIES

Albany County.—From the dump of the Electrolytic mine (long known as the Rambler) two cars of copper ore, carrying also gold, silver, platinum, and palladium, were shipped to refineries at Irvington, N. J., and Chicago, Ill. The settlement for this ore included a calculation of the value to the refinery of the rare-metal content in addition to the other metals, on a basis of assay, less deductions. The main shaft on this property is caved, but a new shaft has been sunk, on new claims adjoining the Rambler.

Fremont County.—The Williams-Luman (De Pass) mine, in sec. 23, T. 40 N., R. 92 W., about 10 miles from Lysite, was first opened 12 years ago and finally reached a depth of 1,000 feet and included 1,000 feet of drifts on the 200, 300, 400, and 800 foot levels. A total of 12 to 14 cars of copper ore had been shipped from this property prior to 1923. In 1923 the property was visited by two miners, who mined and shipped two cars of ore, carrying 0.15 ounce of gold to the ton and 16 per cent of copper.

Platte County.—From lenses in the Sunrise iron deposit, at Hartville, several hundred tons of oxidized copper ore was shipped to Garfield, Utah.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN NEW MEXICO[1]

(MINE REPORT)

By Charles W. Henderson

PRODUCTION

The total calculated gross value of the gold, silver, copper, lead, and zinc recoverable from ore and gravel produced in New Mexico in 1923 was 96 per cent more than the value in 1922. The value for 1922 showed an increase of 122 per cent over that in 1921. In 1923 there were 120 producing mines, of which 104 were deep and 16 were placers, an increase of 30 deep mines but a decrease of 1 placer.

Mine production of gold, silver, copper, lead, and zinc in New Mexico in 1923

	Ore	Gold*	Silver*	Copper	Lead	Zinc	Total value
	Short tons		*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
1923	3,111,050	$551,713	747,127	61,356,802	3,832,427	16,496,000	$11,573,805
Increase or decrease from 1922	+1,534,130	+139,020	−5,113	+29,419,595	+820,204	+11,999,194	+5,675,359

*Includes placer production.

ORE

The quantity of ore sold or treated in 1923 in New Mexico was 3,111,050 tons, an increase of 97 per cent from 1922. Copper ore amounted to 2,946,800 tons; zinc ore 82,390 tons; dry silver ore 62,149 tons; and the remainde was lead-zinc ore, lead ore, dry gold ore, and copper-lead ore named in order. Amalgamation of 3,296 tons of dry gold ore and cyanidation of 47,644 tons of dry silver ore, followed in part by concentration on tables, yielded an average in bullion and concentrates of 0.226 ounce of gold and 7.837 ounces of silver to the ton.

GOLD

The gold recoverable from ore and gravel mined in New Mexico in 1923 amounted to 26,689.12 fine ounces, valued at $551,713. Hidalgo County produced 39.3 per cent of the total, Catron 32.5 per cent, Grant 15.5 per cent, Colfax 9.2 per cent, and Lincoln 1.7 per cent. Dry and siliceous ore yielded 46.9 per cent.

[1] For reports on geology and description of mines, see Lindgren, Waldemar, Graton, L. C., and Gordon, C. H., The ore deposits of New Mexico; U. S. Geol. Survey Prof. Paper 68, 1910; also Finlay, J. R., Report of appraisal of mining properties of New Mexico to tax commissioners, Santa Fe, N. Mex., 1921–22. Comparative statistics for the years 1904 to 1922 have been published in Mineral Resources for 1922.

SILVER

The silver recoverable from ore and gravel mined in New Mexico in 1923 amounted to 747,127 fine ounces, valued at $612,644, compared with 752,240 fine ounces, valued at $752,240, in 1922. Catron County produced 53.4 per cent, from the siliceous ore of the Mogollon district; Hidalgo County 20 per cent, chiefly from the Lordsburg district; Grant County 12.6 per cent, chiefly from the Chloride Flat, Central, and Pinos Altos districts; Sierra County 10.8 per cent, chiefly from the Lake Valley, Chloride, and Kingston districts; and Socorro County 2.1 per cent, from the Magdalena district. Placer mines yielded 30 ounces of silver.

Dry and siliceous silver ore yielded 72.1 per cent, chiefly from Catron, Sierra, Grant, and Hidalgo counties; copper ore 22 per cent, chiefly from Hidalgo, Sierra, and Grant counties; and lead ore 4.7 per cent, chiefly from Grant, Socorro, Luna, and Hidalgo counties.

COPPER

The recoverable copper in the ore mined in New Mexico in 1923 amounted to 61,356,802 pounds, valued at $9,019,450. Of this total 99.7 per cent was produced in Grant and Hidalgo counties, chiefly from the Chino Copper Co.'s operations in the Central district and from the Eighty Five mine, in the Lordsburg district. Copper ore yielded 99.7 per cent of the total.

LEAD

The recoverable lead in the ore mined in New Mexico in 1923 amounted to 3,832,427 pounds, valued at $268,270. The principal lead-producing districts were the Magdalena, in Socorro County; the Central, in Grant County; the Gallinas Mountains, in Lincoln County; the Eureka, in Grant and Hidalgo counties; and the Sacramento Mountains, in Otero County.

ZINC

The total zinc recoverable from ore mined in New Mexico in 1923 amounted to 16,496,000 pounds, valued at $1,121,728. The principal zinc-producing districts were the Central (Hanover), in Grant County, and the Magdalena (Kelly), in Socorro County.

OUTPUT OF ORE AND METAL CONTENT

Ore and metals produced in New Mexico in 1923

Source	Ore	Gold	Silver	Copper	Lead	Zinc
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Dry gold ore	4,693	3,448.74	5,680	16,409	24,000	----------
Dry silver ore	62,149	9,064.22	538,927	76,860	80,355	----------
Copper ore	2,946,800	13,850.90	164,699	61,179,811	22,010	----------
Copper-lead ore	571	----------	2,976	36,169	232,357	----------
Lead ore	6,675	121.21	34,815	47,553	2,598,665	----------
Lead-zinc ore	7,772	----------	----------	----------	854,050	3,241,000
Zinc ore	82,390	----------	----------	----------	20,990	13,255,000
	3,111,050	26,485.07	747,097	61,356,802	3,832,427	16,496,000
Placers	----------	204.05	30	----------	----------	----------
	3,111,050	26,689.12	747,127	61,356,802	3,832,427	16,496,000

Metallic content of ores sold or treated in New Mexico in 1923

Dry and siliceous gold and silver ore

County	Ore	Gold	Silver	Copper	Lead
GOLD ORE	*Short tons*	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Colfax	2,315	2,357.07	423	592	
Grant	656	389.96	3,538	13,178	24,000
Lincoln	880	440.79	37		
Santa Fe	5	12.70	2		
Sierra	836	242.70	1,678	2,639	
Taos	1	5.52	2		
	4,693	3,448.74	5,680	16,409	24,000
SILVER ORE					
Catron	47,644	8,676.11	398,714		
Grant	6,550	353.92	50,644	62,158	66,912
Hidalgo	2,034	17.61	19,000	2,710	1,329
Sierra	5,455	11.08	62,197	11,992	12,114
Socorro	466	5.50	8,372		
	62,149	9,064.22	538,927	76,860	80,355

Copper ore

Grant	2,851,203	3,294.02	16,355	56,725,186	675
Hidalgo	95,055	10,470.39	128,603	4,332,472	20,700
Lincoln	7		89	2,797	300
Rio Arriba	8		1,163	1,299	
Santa Fe	100	21.93	294	23,102	
Sierra	148	57.90	16,918	46,838	
Socorro	204	6.61	1,226	36,757	335
Torrance	59		15	6,476	
Valencia	16		36	4,884	
	2,946,800	13,850.90	164,699	61,179,811	22,010

Copper-lead ore

Lincoln	571		2,976	36,169	232,357

Lead ore

Grant	3,714	25.02	23,834	25,390	1,453,450
Hidalgo	451	5.70	2,180	2,056	201,928
Luna	536	62.89	2,312	1,041	85,472
Otero	606	17.70	345	5,435	195,943
Sierra	2		21		728
Socorro	1,366	9.90	6,123	13,631	661,144
	6,675	121.21	34,815	47,553	2,598,665

Zinc ore

County	Ore	Lead	Zinc
	Short tons	*Pounds*	*Pounds*
Dona Ana	25		14,000
Grant	81,969	20,990	13,017,000
Socorro	396		224,000
	82,390	20,990	13,255,000

Lead-zinc ore

Grant	87	8,700	44,000
Socorro	7,685	845,350	3,197,000
	7,772	854,050	3,241,000

PLACER OUTPUT

Placer output of gold and silver in New Mexico in 1923

County	Gold		Silver		Total value
	Fine ounces	Value	Fine ounces	Value	
Colfax	87.61	$1,811	7	$5	$1,816
Grant	62.89	1,300	21	17	1,317
Lincoln	6.63	137			137
Santa Fe	46.92	970	2	2	972
	204.05	4,218	30	24	4,242
Increase or decrease from 1922	+13.84	+286	−9	−15	+271

SMELTERS

The only smelting plant in the State—the zinc oxide plant at Waldo, near Cerrillos—was idle in 1923. Ore from New Mexico was sent to the lead and copper plants of the El Paso Smelting Works, at El Paso, Tex.; the Copper Queen copper smelter and the Calumet & Arizona copper smelter, at Douglas, Ariz.; the Ozark zinc-lead oxide plant, of Coffeyville, Kans.; and the Empire Zinc Co.'s zinc oxide plant at Canon City, Colo. Small shipments of zinc ore were made to Collinsville, Okla., and Mineral Point, Wis., and of lead ore to the Eagle Picher Lead Co.'s smelter at Galena, Kans.

MINING INDUSTRY

The conspicuous feature of the production of metals in 1923 in New Mexico was the output of 61,356,802 pounds of copper, which was comparable with the average production for the three years 1913, 1914, and 1915 and was greater than the average production for 1919 and 1920, more than four times the production for 1921, and nearly twice that for 1922. The bulk of the copper produced in New Mexico for years has come from the Santa Rita mines of the Chino Copper Co., which mines a large area of low-grade copper ore with steam shovels and transports the ore over a broad-gage railroad to Hurley, N. Mex., where it has a concentration and oil-flotation mill of 12,000 tons capacity, built in seven units. Reconstruction at this mill is described in the review by counties.

Conditions in the copper market which allowed the Chino mines and mill to operate at increased capacity affected likewise copper mines and smelters in Arizona, and Arizona smelters made a stronger demand than in 1922 for the siliceous copper-gold-silver bearing ores of Lordsburg, N. Mex., with the result that the quantity of ores shipped from that district increased more than 50 per cent, and the increase for the district was nearly 100 per cent in gold and more than 30 per cent for both silver and copper. Heap-leaching operations at Tyrone added an appreciable quantity to New Mexico's copper output in 1923. Next in size to the increase in copper was the increase in output of zinc from mines at Hanover and at Kelly. Despite the discontinuance after June 2, 1923, of the fixed price for silver of $1 an ounce under the Pittman Act, with the

consequent decline to an average of about 64 cents an ounce for the rest of the year, the Mogollon district produced almost exactly the same quantity of ore as in 1922, but the ore was of higher grade, with the result that a considerable increase in quantity was recorded for both gold and silver. Other noteworthy features were the continuation for the first half of the year of gold production at Baldy; the continuation, though less than in 1922, of silver production in Sierra County; the shipments of copper-lead ore from the Gallinas Mountains district, Lincoln County, and of lead ore from the Sacramento Mountains district, Otero County; and the renewal of gold production at Whiteoaks.

Mine production of gold, silver, copper, lead, and zinc in New Mexico in 1923, by counties

County	Number of mines producing	Ore (short tons)	Gold*		Silver*	
			Fine ounces	Value	Fine ounces	Value
Catron	9	47,644	8,676.11	$179,351	398,714	$326,945
Colfax	6	2,315	2,444.68	50,536	430	352
Dona Ana	1	25				
Grant	42	2,944,179	4,125.81	85,288	94,392	77,401
Hidalgo	13	97,540	10,493.70	216,924	149,783	122,822
Lincoln	5	1,458	447.42	9,249	3,102	2,544
Luna	5	536	62.89	1,300	2,312	1,896
Otero	4	606	17.70	366	345	283
Rio Arriba	1	8			1,163	954
Santa Fe	7	105	81.60	1,687	298	245
Sierra	14	6,441	311.68	6,443	80,814	66,267
Socorro	9	10,117	22.01	455	15,721	12,891
Taos	1	1	5.52	114	2	2
Torrance	2	59			15	12
Valencia	1	16			36	30
	120	3,111,050	26,689.12	551,713	747,127	612,644
Increase or decrease from 1922	+29	+1,534,130	+6,725.10	+139,020	−5,113	−139,596

County	Copper		Lead		Zinc		Total value
	Pounds	Value	Pounds	Value	Pounds	Value	
Catron							$506,296
Colfax	592	$87					50,975
Dona Ana					14,000	$952	952
Grant	56,825,912	8,353,409	1,574,727	$110,231	13,061,000	888,148	9,514,477
Hidalgo	4,337,238	637,574	223,957	15,677			992,997
Lincoln	38,966	5,728	232,657	16,286			33,807
Luna	1,041	153	85,472	5,983			9,332
Otero	5,435	799	195,943	13,716			15,164
Rio Arriba	1,299	191					1,145
Santa Fe	23,102	3,396					5,328
Sierra	61,469	9,036	12,842	899			82,645
Socorro	50,388	7,407	1,506,829	105,478	3,421,000	232,628	358,859
Taos							116
Torrance	6,476	952					964
Valencia	4,884	718					748
	61,356,802	9,019,450	3,832,427	268,270	16,496,000	1,121,728	11,573,805
Increase from 1922	29,419,595	4,707,927	820,204	102,598	11,999,194	865,410	5,675,359

*Includes placer production.

Gold and silver contained in bullion produced at mills in New Mexico, 1923

Process	Ore	Gold	Silver	Quicksilver used	Sodium cyanide used
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Amalgamation	3,296	2,646.94	434	250	
Cyanidation	47,644	6,950.94	327,727		61,391
	50,940	9,597.88	328,161	250	61,391

Mine production of metals from gold and silver mills in New Mexico in 1923

County	Ore to gold and silver mills	Bullion		Concentrates and recoverable content			
		Gold	Silver	Short tons	Gold	Silver	Copper
	Short tons	*Fine ounces*	*Fine ounces*		*Fine ounces*	*Fine ounces*	*Pounds*
Catron	47,644	6,950.94	327,727	67	1,725.17	70,987	
Colfax	2,315	2,166.27	356	41	190.80	67	592
Grant	100	34.36	39				
Lincoln	880	440.79	37				
Taos	1	5.52	2				
	50,940	9,597.88	328,161	108	1,915.97	71,054	592

Average recovery per ton in bullion and concentrates: Gold, 0.226 ounce; silver, 7.837 ounces.

Mine production of metals from concentrating mills in New Mexico in 1923

County	Ore to concentrating mills	Concentrates produced	Gold	Silver	Copper	Lead	Zinc
	Short tons	*Short tons*	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Grant	2,915,884	154,564	3,285.80	15,354	55,350,789		12,672,900
Hidalgo	1,500	30		11,709	1,808	629	
Sierra	1,000	58	89.78	6,895	5,710	286	
	2,918,384	154,652	3,375.58	33,958	55,358,307	915	12,672,900

Mine production of metals from New Mexico concentrates, 1923

	Concentrates	Gold	Silver	Copper	Lead	Zinc
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
1923	154,760	5,291.55	105,012	55,358,899	915	12,672,900
Increase from 1922	88,596	2,747.69	36,058	26,952,585	915	11,361,233

Mine production of metals from New Mexico crude ore shipped to smelters, 1923, by counties

County	Ore	Gold	Silver	Copper	Lead	Zinc
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Dona Ana	25					14,000
Grant	28,195	742.76	78,978	1,475,123	1,574,727	388,100
Hidalgo	96,040	10,493.70	138,074	4,335,430	223,328	
Lincoln	578		3,065	38,966	232,657	
Luna	536	62.89	2,312	1,041	85,472	
Otero	606	17.70	345	5,435	195,943	
Rio Arriba	8		1,163	1,299		
Santa Fe	105	34.68	296	23,102		
Sierra	5,441	221.90	73,919	55,759	12,556	
Socorro	10,117	22.01	15,721	50,388	1,506,829	3,421,000
Torrance	59		15	6,476		
Valencia	16		36	4,884		
	141,726	11,595.64	313,924	5,997,903	3,831,512	3,823,100

REVIEW BY COUNTIES

CATRON COUNTY

Mogollon district.—The Mogollon Mines Co.'s Last Chance 40-stamp 150-ton cyanidation and concentration mill was operated continuously, chiefly on ore from its Last Chance-Top group and from the Confidence-Dutch Boy group (under option). The Last Chance mill also treated some ore from the Oaks Co. group (Pacific and other claims). The Mogollon Mines Co. in March took over on option the American Silver Corporation group (known as the Fanney) and from April 1 did continuous development work at that property. Certain levels from the Fanney shaft were extended into the ground of the Alberta group, from which several hundred tons of ore was mined and milled at the Last Chance mill. Until June the Sinaloa Exploration & Development Co. continued to operate the Deadwood mine and cyanidation-concentration mill, making a product of silver-gold bullion and one lot of silver-gold concentrate. The Fanney mill remained idle. Assessment work on the Trilby group yielded several tons of silver ore, which was milled at the Last Chance mill, and assessment work on the Cellerier group yielded several small specimens of rich silver minerals, which were shipped to the Denver Mint.

Mine production of gold and silver in Mogollon or Cooney district, Catron County, N. Mex., in 1923

	Ore	Gold	Silver	Total value
	Short tons		*Fine ounces*	
1923	47,644	$179,351	398,714	$506,296
Increase or decrease from 1922	−462	+37,218	+76,254	+41,703

COLFAX COUNTY

Baldy district (Elizabethtown, Therma, Baldy).—Lessees operated the Aztec mine and amalgamation mill on ore from pillars and stope filling until May 24, when a fire destroyed the old Aztec mill and a new mill just completed on the property. Several tons of highly silicified metamorphosed shale from the Ajax mine containing gold accompanied with magnetite was tested by amalgamation in the

10-stamp mill on the property, resulting in the shipment of a small bar of amalgam bullion to the Denver Mint. The Lowrey and Little Nigger Gulch placers, at Elizabethtown; the Paterson placer, on Willow Creek; and the Ute Creek placers, on Ute Creek, were operated by sluicing, booming, and patented rocker, respectively.

Some development work was done on the Black Horse property, near Baldy; on the Red Bandana property near Elizabethtown; and on the Klondyke mine in the West Moreno district. A mill was under construction at the Klondyke mine.

Mine production of gold, silver, and copper in Elizabethtown district, Colfax County, N. Mex., in 1923[a]

	Ore	Gold		Silver*	Copper	Total value
		Placer	Deep			
	Short tons			*Fine ounces*	*Pounds*	
1923	2,315	$1,811	$48,725	430	592	$50,975
Increase or decrease from 1922	−1,415	+339	−27,616	−140	+592	−27,408

*Includes placer production.

DONA ANA COUNTY

One car of zinc oxide ore was shipped from the Memphis mine, in the Organ Mountain district.

GRANT COUNTY[2]

Burro Mountain district.—Surface heap-leaching experiments on low-grade copper ore from waste dumps at the mines of the Burro Mountain branch of the Phelps Dodge Corporation resulted in the recovery of a considerable quantity of copper precipitates. Lessees working underground shipped copper ore of fairly good grade. Both products were shipped to the Copper Queen smelter, Douglas, Ariz. This mine has a considerable reserve of low-grade copper ore and a 2,000-ton table-concentration and oil-flotation mill, idle since March 31, 1921.

Central district.—The Chino Copper Co., operating a large area of "porphyry copper" ore at Santa Rita, and a mill capable of treating 12,000 tons a day, in seven units, at Hurley, made notable improvements in 1923 at both mines and mills. At the mines the improvements consisted principally of the addition of heavier mining equipment and the increase of the water supply. At the mill reconstruction and reequipment of the concentrating department and alterations and replacements in all other departments went on throughout the year in units. Milling of ores continued throughout the year at nearly 50 per cent increase in tons per day as compared with 1922. The Empire Zinc Co.'s magnetic-separation mill at Hanover was operated steadily, and the product, a high-grade zinc sulphide concentrate, went to the company's zinc oxide plant at Canon City, Colo. Several thousand tons of comparatively high-grade lead oxidized ore, low in

[2] For a description of the geology of Bear Mountain, Burro Mountain, Chloride Flat, Fierro, Fleming, Georgetown, Hanover, Lone Mountain, Pinos Altos, and Santa Rita, see Paige, Sidney, U. S Geol. Survey Geol. Atlas, Silver City folio (No. 199), 1916.

silver, was shipped from the Lucky Bill mine, and several hundred tons of zinc oxidized ore and one car of zinc sulphide ore was shipped from the Combination mine, both near Bayard. Lessees shipped copper ore from the Blue Bell claim, near Fierro. Copper and lead ores in small lots were shipped from several other properties in the Central district. Large quantities of iron ore were shipped from the iron deposits at Fierro to the Colorado Fuel & Iron Co.'s steel mill, at Pueblo, Colo.

The fourteenth annual report of the Chino Copper Co., for the year ending December 31,1923 (included in the fifteenth annual report of the Ray Consolidated Copper Co.), says:

Mining development.—A tunnel was driven during the year at the east end of the Hearst pit with a view to prospecting ore that was disclosed in the east slope of the South ore body. Ore of milling as well as direct shipping grade was extracted from this work. No attempt was made, however, to stope the ore body, as at this time it would interfere with the benches above. Another tunnel was driven from the western prong of the South ore body in order to demonstrate the extension of ore indicated but not disclosed by previous drill holes. The ore extracted during the progress of this exploration was high grade, practically all of it being shipped to the smelter. This work demonstrated the extension of sufficient ore to warrant the widening of the pit to the north through this section.

In November a diamond-drill hole was started in the west prong of the Southwest ore body, pointing in a southwesterly direction and at an angle of 15° downward from the horizontal so as to crosscut any ore extension to the north of the most northerly boundary of the Estrella ore body. Up to the end of the year nothing but low-grade material had been encountered. There was some difficulty and delay in getting through the shattered areas of the steam-shovel benches above. Good progress was made after reaching undisturbed ground. The last reports, cores, and sludge samples show 35 feet of ore encountered averaging over 3 per cent copper. The drillings still show mineral, and the outlook is promising for substantial increases of relatively high-grade ore in this direction.

Ore reserves.—Remaining undeveloped ore reserves of 101,163,114 tons are indicated by the difference between those stated in the last annual report and the tonnage mined during the year.

Mining operations.—During the first part of the year there were 9 shovel crews working in the various pits. By the end of the third quarter the number had been increased to 13—7 working on day and 6 on night shift. * * *

Construction and improvements at the mill.—In the early part of the year work of remodeling the gravity portion of section No. 2 was in progress, but it was not until April that the new classifying apparatus could be received, installed, and thoroughly tested. Results being satisfactory and certain factors determined, orders were placed for this type of machine to replace those that had heretofore been in use throughout the mill, but owing to manufacturing delays, shipment could not be effected until near the end of the year. In the meantime it had been determined that better and more economical results could be obtained by discarding the vanner equipment from the flow sheet as an unnecessary operation intermediary to the improved gravity system developed and the flotation department. One-half of section No. 7 was operated with the modified type of flotation machine, and as soon as two strings of these were completed they were put into operation. The records of their performance demonstrated their superiority both from an operating and metallurgical aspect. All of one-half section No. 7 was completed by the end of July. In the meantime dismantling of the vanners in sections 4 and 5 and the removal of floors continued. By the latter part of June the work was well in progress, and installation of new apparatus was pushed as rapidly as possible. By the early part of October sections 4 and 5 had been reequipped, and effects of the new flow sheet were felt in the general milling results. Section 3, in the meantime, had been entirely dismantled in order to remodel it in accordance with the gravity portion of section 2 and the new equipment replacing the vanners already installed in half of section 7 and sections 4 and 5. It was, however, near the end of the year before the classifying portion of this section was received for installation, although advantage was taken of using the new con-

centrating machines as soon as they were completed. The experimental machines in the other half of section No. 7 were shut down in order to permit the installation of the new type of concentrating machinery and to make this an original as well as an experimental section. By the end of the year all of the vanners had been dismantled, floors removed, and sections 1, 2, and 6 prepared for the new equipment. The work was carried on with the view of interfering as little as possible with the operation of four sections and the regrinding portion of section 6, but at the close of the year only section 3 could be said to be approximately complete in accordance with the new flow sheet, as it was necessary to keep some of the old concentrating machinery in operation, and the new equipment was not, except as to one portion, entirely constructed; old type of machines still being used in the flow sheet. However, the amount of expenditure to complete this section is comparatively small. The improved results during the last quarter of the year demonstrate the efficiency of the flow sheet, although it will be some months before it is possible to make all the changes necessary to obtain the full benefit.

Mill operations.—Four sections of the Hurley mill, with the regrinding portion of a fifth section, were in operation throughout the year. For the first nine months operations were most difficult, owing to the dismantling and remodeling of various sections, but by the last quarter interference from construction necessities was considerably relieved.

There was a total of 2,785,564 tons of ore treated, equivalent to an average of 7,632 tons per day, as compared with 5,267 tons per day for the operating period in 1922.

The average copper content of the ore treated during the year was 1.50 per cent, approximately 0.05 per cent lower than for 1922, but practically the average grade of the ore remaining in the mine.

The total production of concentrates was 136,590 dry tons, averaging 20.28 per cent copper, corresponding to a recovery of 19.88 pounds per ton. This is equivalent to an extraction of 66.34 per cent. In connection with the statement made on the remodeling of the mill, it is of interest to note that for the first nine months of the year the recovery per ton of ore treated was 18.66 pounds per ton, corresponding to a mill recovery of 63.56 per cent, while for the last quarter, with such of the new equipment as was completed and in operation, but with a slightly higher head, the recovery was 24.05 pounds per ton, an average mill extraction of 75.03 per cent.

The average cost of milling was 94.48 cents per ton, as compared with 92 cents for the year 1922. Major repairs to ore bins and other parts of the mill, aside from the remodeling, were necessary, and in addition an unusual amount of labor was required in operation, due to interference through construction work.

Production and cost of copper.—The production of copper as contained in the concentrates was 55,391,880 pounds, as compared to 29,508,582 pounds produced during 1922. In addition to the copper from mill operations, precipitates and ore were shipped direct from the mine to the smelter, bringing the total production of copper up to 56,544,174 pounds, which, after allowing for smelter deductions, made the net output of refined copper 54,261,228 pounds. The average operating cost per pound of net copper produced for the period, exclusive of charge for depreciation and after crediting precious-metal values and miscellaneous income, amounting to 0.37 cent per pound, was 12.9 cents, as compared with 11.2 cents for the previous year.

During the period under discussion the milling plant was not operated up to its full tonnage capacity, due to the fact that operations were interfered with to some extent throughout the year by the general remodeling of the mill and the extensive repairs necessary to be made on the coarse-ore bins and other parts of the plant. By the end of the year all repairs of an extraordinary nature had been practically completed.

During the year the main expenditures at the mine were for additional equipment looking toward expanding operations and greater efficiency, and at the mill for alterations and construction necessary to simplify operation, to improve flow sheet, to obtain increased recoveries, and to decrease costs of treating the regular run of sulphide ores. In carrying out this general plan it was necessary to dismantle the experimental unit in connection with section No. 7, and for the time being tests on semioxidized ore have ceased, but in connection with the re-equipment of this section it will be possible, during the current year, to resume the experiments and obtain direct comparison with regular mill operations.

Mine production of gold, silver, copper, lead, and zinc in Central district, Grant County, N. Mex., in 1923

	Ore	Gold	Silver	Copper	Lead	Zinc	Total value
	Short tons		*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
1923	2,885,711	$68,108	29,264	54,374,770	1,311,141	13,017,000	$9,062,131
Increase from 1922	1,458,928	43,571	17,938	25,966,586	958,501	11,683,560	5,095,762

Chloride Flat district.—Leases on the Boston Hill and Chloride Flat claims of the Stevens estate were canceled in February, 1923, so that only a few hundred tons of silver ore, containing some lead, iron, and manganese, was shipped from the Chloride Flat group in 1923, and only a small quantity of iron-manganese ore was shipped to steel mills from the Boston Hill group, as compared with a large quantity in 1922. Several thousand tons of silver-iron-manganese ore was shipped from the Grand Central, Seventy-Six, and Bremen mines. Iron-manganese ores were shipped from the Clan-Seven Sisters claims to the Colorado Fuel & Iron Co.'s steel mill at Pueblo, Colo., from August through December.

Eureka district.—Five hundred tons of silver-lead sulphide ore was shipped from the American mine. (See also Hidalgo County.)

Gold Hill district.—The Cline 2-stamp amalgamation mill was operated for a time on oxidized gold ore from the Roosevelt-Gold Dollar group. Several hundred tons of silver ore was shipped from the Good Luck group from February through November.

Lone Cone district.—One small lot of lead-silver ore was shipped from the Ruby Flat-Ben Hur group, near Hurley. Some manganese ore was also shipped to steel mills from this group.

Pinos Altos district.—Both placer and deep mine production in the Pinos Altos district fell off in 1923. The mining of silver ore from the Houston-Thomas mine and the shipments of silver ore from the Martin dump ceased before the expiration of the Pittman Act in June. From the Langston mine several hundred tons of gold ore, containing also some silver, copper, and lead, was shipped to El Paso and two cars of lead-zinc ore went to Coffeyville, Kans. One car of lead ore was shipped from the West View claim. Placer mines in the Pinos Altos district produced 62.89 fine ounces of gold and 21 fine ounces of silver in 1923.

Mine production of gold, silver, copper, lead, and zinc in Pinos Altos district, Grant County, N. Mex., in 1923

	Ore	Gold		Silver	Copper	Lead	Zinc	Total value
		Placer	Deep					
	Short tons			*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
1923	2,968	$1,300	$12,988	17,404	68,129	90,471	44,000	$47,899
Increase or decrease from 1922	−4,912	−779	−6,154	−38,416	+41,936	−583,376	+44,000	−69,740

Steeplerock district.—A car of silver ore was shipped from the Norman King mine.

White Signal district.—A car of lead-silver ore was shipped from the Lucky Seven-Dandy group.

HIDALGO COUNTY[3]

Eureka district (Hachita), including Apache district.—Several cars of copper ore, mined in 1922 from the Apache and Crown Point mines, were shipped to the El Paso smelter in 1923. A small shipment of lead ore was made from the King 400 mine. (See also Eureka district, Grant County.)

Gillespie district (Red Hill).—Several hundred tons of lead ore was shipped from the Red Hill group, south of Hachita.

Lordsburg district (including Pyramid and Virginia or Shakespeare districts).—In 1923 there was an increased demand at the copper smelters of Douglas, Ariz., for the highly siliceous gold-silver-copper ore of the Lordsburg district. A large quantity of this ore was shipped from the Eighty-Five mine to the Calumet & Arizona smelter. Lessees on the Atwood mine shipped a considerable quantity of similar ore to the copper department of the smelter at El Paso, Tex., and to the Copper Queen smelter, Douglas, Ariz. Lessees on the Bonney mine also shipped similar ore to the Copper Queen smelter and lead ore to the lead plant of the El Paso smelter. Lead ore was also shipped from the Anita, Bonney, Homestake-Needmore, and Robert E. Lee groups. Dry silver ore from the Last Chance mine was milled at a high ratio of concentration to make a car of high-grade silver concentrate carrying also some copper. Several cars of silver ore with siliceous gangue were shipped from the Venus mine.

Mine production of gold, silver, copper, and lead in Lordsburg district, Hidalgo County, N. Mex., in 1923

	Ore	Gold	Silver	Copper	Lead	Total value
	Short tons		*Fine ounces*	*Pounds*	*Pounds*	
1923	96,587	$216,554	141,538	4,314,122	46,185	$970,024
Increase or decrease from 1922	+35,296	+101,643	+34,027	+1,097,537	−56,106	+307,737

Steins (Kimball) district.—Several cars of silver ore were shipped from the Volcano mine, reopened in 1921–22, after a long idleness.

LINCOLN COUNTY

Jicarilla district.—Several small lots of placer gold, recovered by panning of stream gravel, were sold from the Jicarilla district.

Red Cloud district (Gallinas Mountains).—At the Deadwood-Red Cloud mine, opened by a 200-foot shaft, 400 feet of drifts and crosscuts were driven in 1923, and several hundred tons of lead-copper-silver ore was mined and shipped.

Whiteoaks district.—The Homestake amalgamation mill, with a record of small but continuous production of gold bullion for many years up to 1920, was again in operation in 1923.

[3] For review of districts in reports prior to 1920, see Grant County.

LUNA COUNTY

Fremont district.—From the Keno mine, in the Fremont district (nearest post office Hachita), developed by an inclined shaft on the vein to a depth of 200 feet and by drifts at 50-foot intervals, there was shipped a car of lead-silver ore in 1923. Two cars of similar ore were shipped from the Rattlesnake property.

Cooks Peak district (north of Deming).—A small lot of lead ore was shipped from the Sycamore-Burrell-Florida group of claims, in the northern part of the Cooks Peak district but just over the county line in Grant County. The ore is reported to be associated with fluorspar.

Victorio district (Gage).—Several hundred tons of lead-silver-gold ore was shipped from the Helen & Jessie mine and from the Last Chance group.

OTERO COUNTY

Orogrande district.—Several cars of lead-silver and lead-silver-gold ores were shipped from the Orogrande district, which was until 1922 a contributor of iron ore to the steel plant at Pueblo, Colo., and until 1921 of iron-copper-gold ore to the El Paso smelter.

Sacramento Mountains district (Alamogordo).—Several hundred tons of lead ore, containing only traces of silver, was shipped from the the Alamo group. This property is opened by a 400-foot adit.

RIO ARRIBA COUNTY

A small lot of relatively high-grade copper-silver ore was shipped from the Bromide mine, near Tusas.

SANDOVAL COUNTY

Cochiti district (Bland).—Development work was done at the Gold Range group and assessment work at the Crown Point group. The Crown Point group is equipped with a 100-ton cyanidation plant, which was operated during 1914–1916, producing silver-gold bullion.

SAN MIGUEL COUNTY

No development work was done at the Pecos mine, at the junction of Willow Creek and Pecos River, 12 miles from Santa Fe, but several testing plants were working on test lots of the ore in an endeavor to find a metallurgical method to treat the ore. The mine is said to contain a large quantity of complex copper-lead-zinc-silver ore.

SANTA FE COUNTY

Cerrillos district.—The Grubnau zinc oxide plant, at Waldo, was idle in 1923.

New Placers district (Golden).—Several small lots of placer gold from the New Placers district were sold in 1923. After an idleness of several years, the San Pedro copper mine was operated in a small way by lessees, who shipped 3 cars of copper-gold-silver ore. A car of copper ore was also shipped from the Golden Cycle mine.

SIERRA COUNTY

Mine production of gold, silver, copper, and lead in Sierra County, N. Mex., in 1923

	Ore	Gold	Silver	Copper	Lead	Total value
	Short tons		*Fine ounces*	*Pounds*	*Pounds*	
1923	6,441	$6,443	80,814	61,469	12,842	$82,645
Increase or decrease from 1922	−3,524	+3,735	−56,028	+22,698	+4,096	−62,620

Sierra County's production in 1923 dropped in value to that in 1921.

Chloride district (*Apache, Cuchillo Negro*).—Lessees on the Great Republic group built a mill, with equipment consisting of a 40-ton ball mill, 3 Butchart concentrating tables, and an 8-cell flotation machine. The mill was operated part of each day for a time on material on the dump, making a product of gold-silver-copper concentrate. A small car of good-grade gold ore was shipped from the McKinley mine. The Midnight-Tidal Wave property was operated only three months. During that time the mill, with equipment of one Ball mill, a Grotch flotation machine, and Wilfley tables, produced several lots of concentrate, containing a relatively high content of silver. From the Silver Monument property were sold a car of copper ore and two cars of copper concentrate, both ore and concentrate carrying a relatively high content of silver.

Hillsboro district (*Las Animas*).—One car of gold ore was shipped from the Sherman or Caballero mine, and several small lots of copper ore, carrying a good content of gold, were shipped from prospects in the Hillsboro district.

Kingston district.—Dry silver ore was shipped from the Lady Franklin, Hornet, and Cumberland groups.

Lake Valley district.—Shipments of siliceous ore, carrying manganese, iron, and silver, to the copper plant of the El Paso smelter, from the Lake Valley mines were continued for part of 1923.

SOCORRO COUNTY

Since the organization of Catron County in the spring of 1921 by separation of the western part of Socorro County, which contained the Mogollon district, the Magdalena district has been the principal producing mining district in Socorro County. The production in other districts left in Socorro County has been nominal during 1921–1923.

Magdalena district (*Kelly*).—There were no company operations at the Ozark Smelting & Mining Co.'s Waldo group, but small groups of lessees mined and shipped a large quantity of zinc-lead sulphide and a considerable quantity of both lead oxidized and zinc oxidized ores. The company's 100-ton flotation mill, for the treatment of zinc sulphide ore, was idle. The manager reports that the Waldo group contains reserves of zinc sulphide ore. Lessees on the Nitt group shipped several cars of copper sulphide ore. Small shipments of copper sulphide and lead sulphide ores were made from the Old Soldier

and Black Cloud groups. Lessees on the Kelly mine of the Empire Zinc Co. shipped lead oxidized and zinc oxidized ores. Lessees on the Juanita mine shipped lead sulphide ore to the lead department of the El Paso smelter and to the Eagle Picher Lead Co.'s smelter at Galena, Kans., and sold zinc oxidized ore to the Empire Zinc Co.

Socorro district.—J. B. Woods shipped a car of lead sulphide ore from a prospect 3½ miles from Socorro.

TAOS COUNTY

Red River district.—During the year an attempt was made to unwater the Black Copper group, with partial success, and a few samples of ore were taken out for testing. A considerable amount of assessment work was done on the Gold Reef-Gold Ledge-Sylvia group, opened by two adits aggregating 3,000 feet.

TORRANCE COUNTY

Two cars of copper ore were shipped from the surface outcrops of copper mineral in limestone and shaly limestone in the Carocito district, north of Scholle, from which several thousand tons of copper ore was shipped in 1916-1919.

VALENCIA COUNTY

A car of copper ore was shipped from Bluewater, Valencia County.

GOLD, SILVER, COPPER, AND LEAD IN TEXAS

(MINE REPORT)

By Charles W. Henderson

Mine production of gold, silver, copper, and lead in Texas, 1923

	Ore (short tons)	Gold	Silver		Copper		Lead		Total value
			Fine ounces	Value	Pounds	Value	Pounds	Value	
1923	78,610	$802	811,824	$665,696	4,257	$625	26,605	$1,862	$668,985
Increase or decrease from 1922	+9,190	+802	+166,844	+20,716	−33	+46	+18,589	+1,421	+22,985

Brewster County.—Less than 1 ton of lead ore was shipped from a prospect near Alpine.

El Paso County.—A small lot of rich gold ore was shipped from Canutillo, probably from the Franklin Mountains, or from the south end of the Organ Mountains, N. Mex.

Hudspeth County.—In the Allamoore district a car of copper ore, carrying a good grade of silver to the ton was mined and shipped from the Circle Ranch claim, several cars of dry silver ore were shipped from the Mohawk claim, and two lots of copper ore were shipped from other prospects.

In the Sierra Blanca district several cars of lead ore carrying a fair content of silver and some gold were shipped from the Black Hill property.

Presidio County.—The Presidio Mining Co. has been engaged since 1884 in mining silver ore from replacement deposits in limestone at the Presidio mine, in the Shafter district. The property is equipped with a 125-ton cyanidation mill, where crushing is done with 15 stamps, followed by fine grinding in two tube mills, classifying, agitating in cyanide solution, filtering, and precipitating by zinc in presses. This mine has produced the greater part of the silver output of Texas, which from 1885 to 1923 amounted to 17,267,304 fine ounces having a commercial value of $12,752,575.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN COLORADO

(MINE REPORT)

By CHARLES W. HENDERSON

PRODUCTION

The total calculated gross value of the gold, silver, copper, lead, and zinc produced from ores mined in Colorado in 1923 showed an increase of 21 per cent over the gross value in 1922. There were appreciable increases in gold, lead, and zinc, a small increase in copper, and a small decrease in silver.

Mine production of gold, silver, copper, lead, and zinc in Colorado in 1923[a]

	Number of producing mines	Ore	Gold		Silver[b]	Copper	Lead	Zinc	Total value
			Placer	Deep					
		Short tons			*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
1923	417	1,569,100	$364,429	$6,227,200	5,334,488	4,248,109	45,698,185	54,152,000	$18,471,590
Increase or decrease from 1922	−63	+157,000	+8,026	+210,184	−521,423	+874,655	+22,220,985	+30,894,000	+3,169,892

[a] A revised table showing the production of gold, silver, copper, lead, and zinc from the beginning of mining in Colorado to 1923 will be included in Professional Paper 138, "Mining in Colorado," now in press.
[b] Includes 4,122 ounces placer production.

ORE

In 1923 amalgamating and cyaniding mills with and without concentrating equipment treated 817,328 tons of ore, from which were recovered in bullion and cyanide precipitates 221,022.18 fine ounces of gold, 44,257 fine ounces of silver, 33,386 tons of concentrates. These concentrates contained recoverable metals as follows: 33,592.14 fine ounces of gold, 1,520,881 fine ounces of silver, 402,831 pounds of copper, and 6,871,134 pounds of lead. The average recovery per ton of ore treated was 0.312 ounce of gold and 1.915 ounces of silver. A total of 549,522 tons of ore went directly to concentrating mills and yielded 117,180 tons of concentrates, or at a ratio of 5 to 1. From these concentrates were recovered 29,188.78 fine ounces of gold, 1,701,789 fine ounces of silver, 2,508,793 pounds of copper, 25,906,075 pounds of lead, and 41,164,400 pounds of zinc. Lead concentrates amounting to 62,979 tons contained 19,096,589 pounds of lead, and 19,563 tons of lead-copper concentrates contained 10,894,822 pounds of lead. The concentrates of all other classes contained only small quantities of lead. The smelting ores contained 12,920,976 pounds of lead, as compared with 11,249,761 pounds in 1922 and 9,236,055 pounds in 1921.

GOLD

The mine production of gold was 318,870.05 fine ounces, valued at $6,591,629, an increase of 10,555.90 fine ounces and of $218,210, following decreases of $461,909 in 1922, $740,991 in 1921, $2,310,308 in 1920, and $2,865,091 in 1919.

The Cripple Creek district increased its output slightly over the low mark of 1922 but contributed only 61 per cent of the total State yield as compared with 63 per cent in 1922. That part of the San Juan region including Dolores, La Plata, Ouray, San Juan, and San Miguel counties yielded $1,693,956, an increase of $430,177. There were increases of $14,674 in Gunnison County, $19,322 in Park, $216,227 in San Juan, $296,122 in San Miguel, and $9,426 in Teller, and decreases of $9,891 in Boulder County, $30,377 in Eagle, $22,524 in Gilpin, $141,554 in Lake, $16,356 in La Plata, $66,753 in Ouray, and $45,720 in Summit.

The output of placer gold in 1923 was $364,429, an increase of $8,026. Summit County, with two dredges, three sluice mines, and three hydraulic mines, produced 56 per cent of the placer gold, and Park County produced 40 per cent. Other placer producing counties were Adams, Chaffee, Gilpin, Lake, and Montrose.

SILVER

The output of silver was valued at $4,374,280, a decrease of $1,481,631. Large decreases in production were made in Boulder, Eagle, Lake, Ouray, and Pitkin counties, and a relatively small decrease in San Miguel County. San Juan County produced six times as much as in 1922, and Mineral County doubled its production.

COPPER

The output of copper was valued at $624,472, an increase of $169,056. San Miguel County produced 33 per cent of the copper output, San Juan 24 per cent, and Eagle 15 per cent.

LEAD

The lead produced, reckoned as lead in lead bullion and as lead in leaded zinc oxide, was valued at $3,198,873, an increase of $1,907,627. There were increases in value in all the important lead-producing counties. San Juan was the first in rank and was followed in order by San Miguel, Lake, Summit, Pitkin, Saguache, and Custer.

ZINC

The zinc ores sold contained recoverable zinc valued at $3,682,336, an increase of $2,356,630. Eagle County produced 23,600,000 pounds, or 44 per cent of the zinc output of the State, as compared with 47 per cent in 1922 and no production in 1921. Lake County produced 9,415,000 pounds, or 17 per cent, in 1923, as against 9,003,000 pounds, or 39 per cent, in 1922, and 1,821,000 pounds, or 77 per cent, in 1921. San Juan County produced 9,540,000 pounds, or 18 per cent, in 1923, as against 1,300,000 pounds, or 6 per cent, in 1922. Other producing counties in order of production were Summit, Gunnison, Clear Creek, Pitkin, Dolores, Chaffee, Mineral, and Fremont.

Zinc and zinc-lead ore and concentrates as sold at the mine and mill in Colorado in 1923

Classification	County	Short tons	Estimated recoverable zinc	Zinc content	Average assay of zinc	Average wet assay of lead
			Pounds	*Pounds*	*Per cent*	*Per cent*
Zinc oxidized ore	Chaffee and Lake	20,513	6,842,000	8,551,859	20.84	----
Zinc sulphide ore and concentrates.	Lake	6,890	2,683,000	3,353,090	24.33	3.64
Zinc-lead sulphide ore and concentrates.	Chaffee, Dolores, Gunnison, Mineral, Pitkin, and San Juan.	20,519	12,929,000	16,172,324	39.41	12.24
Zinc sulphide ore and concentrates.	Clear Creek, Dolores, Eagle, Fremont, Gunnison, Pitkin, and Summit.	76,531	31,698,000	43,238,011	28.25	2.20
		124,453	54,152,000	71,315,284	28.65	3.57

OUTPUT OF ORE AND METAL CONTENT

Ore and metals produced in Colorado in 1923

Source of production	Ore		Gold		Silver	
	Short tons	Per cent	Fine ounces	Per cent	Fine ounces	Per cent
Dry gold ore	410,468	26.16	209,867.04	65.82	56,837	1.07
Dry gold and silver ore	480,340	30.61	67,260.95	21.09	1,567,091	29.38
Dry silver ore	275,662	17.57	6,247.87	1.96	2,330,396	43.68
	1,166,470	74.34	283,375.86	88.87	3,954,324	74.13
Copper ore	4,655	.30	2,139.88	.67	110,552	2.08
Copper-lead ore	380	.02	122.57	.04	16,680	.31
Lead ore	90,410	5.76	3,339.22	1.05	625,974	11.73
Lead-zinc ore	214,185	13.65	11,966.62	3.75	571,619	10.72
Zinc ore	93,000	5.93	296.65	.09	51,217	.96
	402,630	25.66	17,864.94	5.60	1,376,042	25.80
Total deep mines	1,569,100	100.00	301,240.80	94.47	5,330,366	99.93
Total placers	----------	----------	17,629.25	5.53	4,122	.07
Grand total	1,569,100	100.00	318,870.05	100.00	5,334,488	100.00
Increase or decrease from 1922	+157,000	----------	+10,555.90	----------	−521,423	----------

Source of production	Copper		Lead		Zinc	
	Pounds	Per cent	Pounds	Per cent	Pounds	Per cent
Dry gold ore	30,152	0.71	113,264	0.25	----------	----------
Dry gold and silver ore	1,375,938	32.39	10,202,564	22.33	----------	----------
Dry silver ore	1,386,215	32.63	8,382,956	18.34	----------	----------
	2,792,305	65.73	18,698,784	40.92	----------	----------
Copper ore	302,685	7.13	71,194	.15	----------	----------
Copper-lead ore	23,502	.55	76,492	.17	----------	----------
Lead ore	143,791	3.38	10,675,407	23.36	----------	----------
Lead-zinc ore	966,843	22.76	15,519,061	33.96	21,021,400	38.82
Zinc ore	18,983	.45	657,247	1.44	33,130,600	61.18
	1,455,804	34.27	26,999,401	59.08	54,152,000	100.00
Grand total	4,248,109	100.00	45,698,185	100.00	54,152,000	100.00
Increase from 1922	874,655	----------	22,220,985	----------	30,894,000	----------

Placer output in Colorado in 1923, in fine ounces

County	Sluicing and hydraulic		Dredging		Total	
	Gold	Silver	Gold	Silver	Gold	Silver
Adams	16.50	3			16.50	3
Chaffee	34.20	6			34.20	6
Gilpin	6.43				6.43	
Lake	8.81	3	727.65	197	736.46	200
Montrose	8.56	2			8.56	2
Park	13.94	2	6,974.70	1,437	6,988.64	1,439
Summit	180.78	50	9,657.68	2,422	9,838.46	2,472
	269.22	66	17,360.03	4,056	17,629.25	4,122
Increase or decrease from 1922	−218.21	−62	+606.46	−44	+388.25	−106

Content of ores sold or treated in Colorado in 1923

Dry gold ore

County	Ore	Gold	Silver	Copper	Lead
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Boulder	951	1,196.69	1,101		
Clear Creek	1,461	478.99	1,865	4,867	12,046
Dolores	3	5.50	24	11	235
Eagle	102	99.10	741	2,989	
Gilpin	4,365	998.17	3,574	10,577	14,102
Gunnison	3,318	1,112.39	4,484		5,799
Lake	16,258	8,272.91	17,047	9,191	64,440
La Plata	147	213.20	2,672	816	269
Ouray	101	101.30	55	497	
Park	305	751.32	608	68	10,691
Rio Grande	17	80.40	161	218	929
San Juan	560	297.22	494	918	2,578
San Miguel		379.54	168		
Summit	141	106.30	1,237		2,175
Teller	382,739	195,774.01	22,606		
	410,468	209,867.04	56,837	30,152	113,264
Decrease from 1922	39,190	7,739.86	16,354	27,326	62,938

Dry gold and silver ore

Boulder	4	3.33	60		
Clear Creek	3,690	567.88	12,149	3,618	168,446
Custer	500	102.70	1,358		
Gilpin	310	36.30	986		27,791
La Plata	669	554.50	13,660		
Ouray	160	14.37	577		21,116
San Miguel	474,961	65,913.27	1,536,491	1,372,320	9,982,641
Summit	46	68.60	1,810		2,570
	480,340	67,260.95	1,567,091	1,375,938	10,202,564
Increase or decrease from 1922	+83,149	+9,068.64	−189,767	+321,963	+2,979,439

Dry silver ore

Boulder	929	106.10	23,963		8,901
Clear Creek	9,770	31.33	98,188	1,123	123,438
Custer	95	1.40	2,156	1,447	564
Dolores	30	84.30	5,937	116	543
Eagle	32,583	1,690.58	289,575	610,431	111,191
Gilpin	288	43.31	9,393	3,112	14,296
Gunnison	19	2.03	972		
Hinsdale	574	27.70	20,376	3,126	7,967
Lake	47,488	886.20	368,923	225,173	2,150,897
La Plata	22	1.70	806		1,531
Mineral	6,307	88.81	228,462	1,088	185,354
Ouray	86,778	2,715.30	822,811	40,490	1,454,665
Park	93	47.50	10,232	1,400	2,739
Pitkin	44,493		264,180		1,209,414
Saguache	34,275	197.80	152,145	454,266	2,847,782
San Juan	1,799	10.34	5,578	18,970	166,743
San Miguel	7,929	87.26	12,722	11,364	78,755
Summit	2,190	226.21	13,977	14,109	18,176
	275,662	6,247.87	2,330,396	1,386,215	8,382,956
Increase or decrease from 1922	−173,990	−4,173.23	−1,088,313	−531,221	+1,220,227

Content of ores sold or treated in Colorado in 1923—Continued

Copper ore[a]

County	Ore	Gold	Silver	Copper	Lead
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Clear Creek	90	124.64	1,626	7,434	2,455
Dolores	469	5.60	13,949	47,303	22,415
Eagle	1	.70	23	102	
Gilpin	104	189.22	1,171	8,758	
Hinsdale	93	6.91	8,117	6,390	4,566
Lake	3,716	1,795.50	67,501	208,581	38,653
Montrose	101		10,521	17,857	
Ouray	11	3.90	600	573	463
Park	49	10.40	5,672	4,090	2,290
San Juan	17	.91	1,267	853	288
San Miguel	4	2.10	105	284	64
	4,655	2,139.88	110,552	302,685	71,194
Increase from 1922	3,792	1,583.41	79,089	196,821	52,619

Copper-lead ore

Clear Creek	117	111.61	1,276	9,143	21,774
Custer	146	3.78	6,586	7,822	15,824
Hinsdale	5	.30	1,245	384	1,337
Saguache	91	5.58	2,952	4,796	29,301
San Juan	21	1.30	4,621	1,357	8,256
	380	122.57	16,680	23,502	76,492
Increase or decrease from 1922	−247	+38.10	−20,738	−36,797	−86,154

Lead ore

Boulder	76	7.07	14,432		17,828
Chaffee	1,913	791.71	20,756	7,089	551,666
Clear Creek	501	98.80	30,183	958	151,521
Custer	50,459	14.80	18,384	2,167	2,873,940
Dolores	573	43.70	17,403	8,347	105,402
Eagle	34	.70	469		12,773
Gilpin	564	138.92	29,818	437	173,968
Grand	2		323		314
Gunnison	432	5.12	6,987	1,788	255,149
Hinsdale	12	.50	308	175	6,101
Lake	16,280	1,371.00	172,857	68,109	2,897,802
Ouray	210	29.27	16,001	2,237	61,783
Park	24	11.90	750		3,681
Pitkin	13,304		152,864		1,551,707
Saguache	90	1.20	626	415	42,117
San Juan	2,020	426.50	17,985	23,343	516,654
San Miguel	1,170	83.53	56,858	25,012	634,354
Summit	2,746	314.50	68,970	3,714	818,647
	90,410	3,339.22	625,974	143,791	10,675,407
Increase or decrease from 1922	+42,029	−566.91	+132,277	+2,709	+3,613,119

Lead-zinc ore

County	Ore	Gold	Silver	Copper	Lead	Zinc
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Chaffee	51				5,763	23,000
Clear Creek	7,835	65.87	38,587	5,075	537,049	577,000
Dolores	93	.69	589	1,046	24,849	35,400
Gunnison	7,250	34.40	12,496		1,429,482	2,889,000
Lake	5,520	18.20	12,566	722	173,495	158,000
Mineral	155	27.00	405		52,203	41,000
Pitkin	844		12,537		211,493	465,000
San Juan	148,697	10,969.80	441,805	960,000	10,044,424	9,540,000
Summit	43,740	850.66	52,634		3,040,303	7,293,000
	214,185	11,966.62	571,619	966,843	15,519,061	21,021,400
Increase from 1922	192,072	11,662.05	531,563	929,523	13,858,926	13,494,400

[a] All smelting ore.

Content of ores sold or treated in Colorado in 1923—Continued

Zinc ore

County	Ore	Gold	Silver	Copper	Lead	Zinc
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Chaffee	209					109,000
Dolores	225		1,506		8,970	102,600
Eagle	65,707	227.80	31,335	18,983	336,207	23,600,000
Fremont	44	1.31	184		1,999	20,000
Lake	26,713	53.74	16,744		299,671	9,257,000
Summit	102	13.80	1,448		10,400	42,000
	93,000	296.65	51,217	18,983	657,247	33,130,600
Increase from 1922	49,385	295.45	50,926	18,983	645,747	17,399,600

Mine production of metals from gold and silver mills in Colorado in 1923

County	Ore to gold and silver mills	Bullion		Concentrates and recoverable content				
		Gold	Silver	Short tons	Gold	Silver	Copper	Lead
	Short tons	*Fine ounces*	*Fine ounces*		*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Boulder	862	842.16	143	7	8.23			
Clear Creek	1,796	85.69	28	210	183.47	3,882	5,040	29,579
Custer	500	102.70	1,358					
Gilpin	3,883	382.84	111	215	323.89	1,389	5,325	3,927
Gunnison	3,318	921.59	664	99	190.80	3,820		5,799
Lake		312.57	87					
Ouray	41,379	1,117.00	1,255	3,728	869.00	287,860		331,032
Park	100	48.02	67					
San Juan	560	170.32	72	107	126.90	422	918	2,578
San Miguel	382,197	21,298.96	18,208	29,020	31,889.85	1,223,508	391,548	6,498,219
Teller	382,733	195,740.33	22,264					
	817,328	221,022.18	44,257	33,386	33,592.14	1,520,881	402,831	6,871,134
Increase or decrease from 1922	−31,933	+3,473.54	+2,852	−175	−2,812.38	−545,285	−201,348	+923,893

Average recovery per ton in bullion and concentrates: Gold, 0.312 ounce; silver, 1.915 ounces.

Mine production of metals from concentrating mills in Colorado in 1923

County	Ore to concentrating mills	Concentrates produced	Gold	Silver	Copper	Lead	Zinc
	Short tons	*Short tons*	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Boulder	765	51	74.93	4,278		6,720	
Clear Creek	19,940	2,603	571.43	91,562	7,261	750,102	577,000
Custer	50,000	2,042				2,809,528	
Eagle	65,707	37,786	227.80	31,335	18,983	336,207	23,600,000
Gilpin	717	133	85.82	4,025	565	45,063	
Hinsdale	195	39	5.70	3,213	1,159	1,975	
Lake	18,120	3,475	2,080.50	14,260	722	175,419	158,000
Ouray	45,548	4,648	743.67	533,436	40,490	1,144,749	
Pitkin	18,062	4,774		62,170		710,839	
Saguache	34,170	9,032	183.80	146,329	453,199	2,837,543	
San Juan	151,927	23,663	11,188.84	451,796	994,520	10,489,605	9,540,000
San Miguel	100,639	14,514	13,179.71	306,751	991,894	3,559,821	
Summit	43,732	14,420	846.58	52,634		3,038,504	7,289,400
	549,522	117,180	29,188.78	1,701,789	2,508,793	25,906,075	41,164,400
Increase from 1922	247,290	90,451	22,925.88	631,719	2,345,889	19,625,877	40,064,400

Mine production of metals from Colorado concentrates in 1923

By counties

	Concentrates	Gold	Silver	Copper	Lead	Zinc
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Boulder	58	83.16	4,278		6,720	
Clear Creek	2,813	754.90	95,444	12,301	779,681	577,000
Custer	2,042				2,809,528	
Eagle	37,786	227.80	31,335	18,983	336,207	23,600,000
Gilpin	348	409.71	5,414	5,890	48,990	
Gunnison	99	190.80	3,820		5,799	
Hinsdale	39	5.70	3,213	1,159	1,975	
Lake	3,475	2,080.50	14,260	722	175,419	158,000
Ouray	8,376	1,612.67	821,296	40,490	1,475,781	
Pitkin	4,774		62,170		710,839	
Saguache	9,032	183.80	146,329	453,199	2,837,543	
San Juan	23,770	11,315.74	452,218	995,438	10,492,183	9,540,000
San Miguel	43,534	45,069.56	1,530,259	1,383,442	10,058,040	
Summit	14,420	846.58	52,634		3,038,504	7,289,400
	150,566	62,780.92	3,222,670	2,911,624	32,777,209	41,164,400
Increase from 1922	90,276	20,113.50	86,434	2,144,541	20,549,770	40,064,400

By kinds of concentrates

Dry gold	2,468	3,320.15	7,095	6,834	5,996	
Dry gold and silver	139	229.12	5,015		28,316	
Dry silver	10,769	1,142.67	323,470	20,244	613,607	
Lead	62,979	46,882.89	2,286,779	1,464,299	19,096,589	
Lead-copper	19,563	8,937.93	449,231	1,095,688	10,894,822	
Total to copper and lead plants	95,918	60,512.76	3,071,590	2,587,065	30,639,330	
Lead-zinc	12,510	2,247.67	139,073	320,000	1,989,500	9,540,000
Zinc	42,138	20.49	12,007	4,559	148,379	31,624,400
Total to zinc and zinc-lead plants	54,648	[a] 2,268.16	[a] 151,080	[a] 324,559	[b] 2,137,879	[c] 41,164,400
Grand total	150,566	62,780.92	3,222,670	2,911,624	32,777,209	41,164,400

Average content of concentrates

	Gold	Silver	Copper	Lead	Zinc
	Fine ounces per ton	*Fine ounces per ton*	*Per cent*	*Per cent*	*Per cent*
Dry gold	1.35	2.87	0.14	0.12	
Dry gold and silver	1.65	36.08		10.19	
Dry silver	.11	30.04	.09	2.85	
Lead	.74	36.31	1.16	15.16	
Lead-copper	.46	22.96	2.80	27.85	
Average	.63	32.02	1.35	15.97	
Lead-zinc	.18	11.12	1.28	7.95	[d] 47.67
Zinc		.29	.01	.18	[d] 46.89
Average	.04	2.76	.30	1.96	47.07

[a] Recovered in zinc residues.
[b] Lead recovered in zinc residues and leaded zinc oxide.
[c] Zinc recovered as metal and zinc in zinc oxide.
[d] Assay of content; no deduction for loss in smelting.

Mine production of metals from Colorado crude ore shipped to smelters in 1923

By counties

	Crude ore	Gold	Silver	Copper	Lead	Zinc
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Boulder	333	387.87	35,135		20,009	
Chaffee	2,173	791.71	20,756	7,089	557,429	132,000
Clear Creek	1,728	638.53	88,402	19,917	237,048	
Custer	700	19.98	27,126	11,436	80,800	
Dolores	1,393	139.79	39,408	56,823	162,414	138,000
Eagle	32,720	1,791.08	290,808	613,582	123,964	
Fremont	44	1.31	184		1,999	20,000
Gilpin	1,031	613.37	39,417	16,994	181,167	
Grand	2		323		314	
Gunnison	7,701	41.55	20,455	1,788	1,684,631	2,889,000
Hinsdale	489	29.71	26,833	8,916	17,996	
Lake	97,855	10,004.48	641,291	511,054	5,449,539	9,257,000
La Plata	838	769.40	17,138	816	1,800	
Mineral	6,462	115.81	228,867	1,088	237,557	41,000
Montrose	101		10,521	17,857		
Ouray	333	134.47	17,493	3,707	62,246	
Park	371	773.10	17,195	5,558	19,401	
Pitkin	40,579		367,411		2,261,775	465,000
Rio Grande	17	80.40	161	218	929	
Saguache	286	20.78	9,394	6,278	81,657	
San Juan	627	220.01	19,460	10,003	246,760	
San Miguel	1,228	97.18	57,877	25,538	637,774	
Summit	5,233	733.49	87,442	17,823	853,767	45,600
Teller	6	33.68	342			
	202,250	17,437.70	2,063,439	1,336,485	12,920,976	12,987,600
Increase or decrease from 1922	−58,357	−13,419.39	−610,603	−1,269,886	+1,671,215	−9,170,400

By kinds of ore

Dry gold	4,844	8,082.09	24,714	19,736	81,735	
Dry gold and silver	758	665.90	16,288		5,035	
Dry silver	116,943	3,162.61	1,227,957	861,275	3,052,481	
Copper	4,655	2,139.89	110,552	302,685	71,194	
Copper-lead	380	122.57	16,680	23,502	76,492	
Lead	38,976	3,129.63	621,339	128,241	7,587,410	
Total to lead and copper plants	166,556	17,302.69	2,017,530	1,335,439	10,874,347	
Lead-zinc	35,114	119.90	42,771	1,046	2,025,260	12,714,000
Zinc	580	15.11	3,138		21,369	273,600
Total to zinc smelters and zinc oxide plants	35,694	[a] 135.01	[a] 45,909	[a] 1,046	[b] 2,046,629	[c] 12,987,600
Grand total	202,250	17,437.70	2,063,439	1,336,485	12,920,976	12,987,600

Average content of crude ores smelted

Class of ore	Gold	Silver	Copper	Lead	Zinc
	Fine ounces per ton	*Fine ounces per ton*	*Per cent*	*Per cent*	*Per cent*
Dry gold	1.67	5.10	0.20	0.84	
Dry gold and silver	.88	21.49		.33	
Dry silver	.03	10.50	.37	1.31	
Copper	.46	23.75	3.25	.76	
Copper-lead	.32	43.89	3.09	10.06	
Lead	.08	15.94	.16	9.73	
Average	.10	12.11	.40	3.26	
Lead-zinc		1.22		2.88	[d] 24.03
Zinc	.03	5.41		1.84	[d] 29.32
Average		1.27		2.87	24.12

[a] Recovered in zinc residues.
[b] Lead recovered in zinc residues and leaded zinc oxide.
[c] Zinc recovered as zinc in zinc oxide.
[d] Assay of content; no deduction for loss in smelting.

Ores, slimes, and sands treated by amalgamation and cyanidation and gold and silver contained in bullion and precipitates in Colorado in 1923

Process	Material treated	Gold in bullion	Silver in bullion	Quicksilver used	Sodium cyanide used
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Amalgamation	664,450	96,804.79	25,344	4,290	
Cyanidation	[a] 383,595	124,217.39	18,913		[b] 309,565
		221,022.18	44,257		

[a] Includes crude ore treated directly by cyanidation and duplicates 230,717 tons (in form of sands and slimes) from ore treated first by amalgamation.
[b] Reduced to equivalent of 96–98 per cent content.

METAL INDUSTRY

The method employed in Mineral Resources of multiplying the recoverable quantities of gold, silver, copper, lead, and zinc contained in ores produced by metal mines by the average yearly price of each metal gives a basis for yearly comparisons. The recorded figures for 1923 show that the gross value of metals produced in Colorado increased 21 per cent over that in 1922. An analysis of the quantities of metals produced shows that silver was the only metal to show a decrease—521,423 ounces—but the lower average yearly price for silver in 1923 than in 1922 gave a decrease in value for the total silver output of nearly $1,500,000. The increase in the production of the other metals was sufficiently great to overcome this statistical loss of $1,500,000 and to show a net gain for all metals of $3,170,000. The expiration of the Pittman Act (finally decided by the Treasury as June 2, 1923) was anticipated by the smelters in April, May, and June. The return to the market price of silver (average 64.87 cents for the year) on the cessation of the fixed price of $1 an ounce guaranteed to domestic silver producers during 1920, 1921, and 1922 and continued in 1923 until the 208,000,000 ounces melted in 1919 under the Pittman Act approached replacement in the United States Treasury, seriously cut down the net returns of those Colorado mines having ores whose principal constituent was silver. Several large silver mines were closed between July and November, particularly at Leadville, Aspen, and Telluride. The prices for lead and zinc in 1923, $0.07 and $0.068 a pound respectively, as compared with $0.055 and $0.057 in 1922, stimulated the mining of lead and zinc ores, with the result of nearly doubling the quantity of lead produced and more than doubling the quantity of zinc produced. There were notable increases in production of lead in San Juan, San Miguel, Summit, Saguache, and Custer counties. The zinc mines in Colorado were nearly all idle from November, 1920, to November, 1922. The resumption of operations late in 1922 and early in 1923 resulted in a production of zinc somewhat comparable with the average yearly production of zinc in Colorado. The future of Colorado mining is greatly dependent on the price of lead and zinc. Review of the available information as to reserves of ore in Colorado discloses little accurate knowledge of blocked out gold ores but shows

that reserves of lead and zinc ore exist in many of the Colorado mining districts. In 1923 zinc mining was resumed in Eagle, San Juan, and Summit counties but did not increase appreciably in Lake County, hitherto the principal zinc-producing county.

In the production of gold the small increase in value is not indicative of the improvement in the situation. In 1920–21 there was serious danger of the enforced abandonment of all mining in the Cripple Creek gold district. The high costs of the war years of 1917 and 1918 and the continued high costs of 1919 and 1920 had resulted in almost complete cessation of development work. The Portland Gold Mining Co., which had paid $11,692,080 in dividends from 1894 to 1920, had to discontinue dividend payment in December, 1920, and even found itself in debt. The Cresson mine, the mainstay of the Golden Cycle mill, did not seem to have much ore left. Without a regular supply of ore in quantity, such as was furnished by the Cresson mine, the mill could not operate. Should this mill close, most of the mining operations in the Cripple Creek district would cease.

The year 1922 was the turning point in the history of the Cripple Creek district. In August, 1922, the Portland Co. opened on its 2,600-foot level some of the best ore found in the mine below the 1,600-foot level. Though not out of debt, this company bought in 1920 new hoisting machinery capable of sinking to 3,500 feet. The ore opened and developed on the 2,600-foot level in 1922 was ready for shipment in 1923 and materially helped the finances of the company, which also sunk the shaft to the 2,700-foot level. Ore found in the Cresson mine in 1922 had persuaded the Cresson Co. to install a new head frame and hoist, capable of sinking to 3,000 feet. Early in 1923 this installation was completed, and sinking of the shaft from 1,700 to 1,800 feet was begun. Production was maintained throughout 1923 from the 1,700-foot level and above at the rate of 10,000 tons a month. Excellent ore was found on the 1,800-foot level. The Ajax mine, reopened in 1922 as the Tonopah-Ajax, produced ore in 1923, and development work in this mine disclosed ore at depth in the New Market group of the United Gold Mines Co. Some excellent new ore bodies were encountered in the Granite mine. A new company proposes to reopen the Isabella (or Empire Lee). The large acreage of the Stratton estate, which for several years has been operated in a decreasingly small way by local lessees, was covered in December, 1923, by an option obtained by a Boston company, which agreed to reopen the workings of certain of the mining claims and to sink the shafts to greater depth. The Cripple Creek district (Teller County) produced $4,047,008 in gold in 1923, as compared with $4,037,582 in 1922, $4,291,883 in 1921, $4,323,998 in 1920, $5,827,816 in 1919, $8,119,747 in 1918, and $10,394,847 in 1917.

The Reed-Coolbaugh sulphating plant at Durango, completed in August, 1923, was operated for the remainder of the year on the complex zinc-lead-copper-iron-silver-gold concentrates of the Black Bear mine, at Telluride. The Colorado Superior Mining Co. in March, 1923, began mining the ore bodies blocked out at the Black Bear mine, in 1920–1922. The problem of treating this low-grade complex ore had been the inspiration for the development of the Reed-Coolbaugh process and the building of the new Smuggler

Union gravity-concentration and flotation mill. Part of the lead in the Black Bear ore was saved as high-grade lead concentrate on tables, and the remaining sulphides were floated as a complex concentrate. In April, 1923, the Black Bear complex concentrates began moving to Durango for experimentation and storage. The Smuggler Union-Humboldt group above Telluride continued throughout the year to furnish ore to the Smuggler Union amalgamation, gravity-concentration, and flotation mill at Pandora, near Telluride, with a product of silver-gold bullion sold to the Denver Mint and concentrates, sold both to the Durango and to the Leadville smelter. The Tomboy new gravity-concentration and selective-flotation mill at the Tomboy mine, above Telluride, was also operated steadily. Lessees continued work at the Liberty Bell mine and mill. The Liberty Bell Gold Mining Co., a successful operator from 1898 to August, 1921, is in the process of dissolution. The Alta mines and 150-ton gravity-concentration and oil-flotation mill were operated until October, when it was found that a profit could not be made with silver at about 64 cents an ounce. Both the Atlas and the Mountain Top mines and mills, at Sneffels, in Ouray County, produced at about the same rate as in 1922, but the net receipts for the year were heavily reduced because of the decrease of one-third in the amount received for the silver in the concentrate after the expiration of the Pittman Act. Considerable development work was done at Ophir, San Miguel County. Several hundred tons of gold ore was shipped from mines in La Plata County.

Early in 1923 the 500-ton Sunnyside gravity-concentration and selective-flotation mill at Eureka was reopened, and large quantities of lead-silver-gold-copper concentrate were steadily shipped to Durango and zinc-silver-gold-copper concentrate to Texas gas-retort furnaces. Some of the properties at Silverton that were idle in 1921–22 were reopened.

In July, 1923, shipments of lead-silver-iron concentrate at the rate of 2,500 tons a month began to reach the railroad at Shirley over the 7½-mile aerial tram from the Rawley concentration-flotation mill at Bonanza, Saguache County. Owing to an increase in the hardness of the rock and to other difficulties this mine and mill were closed in December. A new mill was built at the Cocomongo mine, and other properties at Bonanza shipped lead-silver ore of excellent grade. The mines at Creede more than doubled their silver and lead production, but the expected increase in production in Hinsdale County indicated by the development work and production in 1922 was not made.

The Eagle zinc mines of the Empire Zinc Co., on Battle Mountain below Red Cliff, which have been extensively developed since 1918 and were sustained during the period of low zinc prices in 1920–1922 by large shipments of pyritous silver ore, began in August, 1922, to ship large quantities of zinc-iron ore to the company's magnetic separation plant and zinc oxide plant at Canon City, and in 1923 they doubled their shipments of ore of that class as well as continued heavy shipments of pyrite silver ore to Utah smelters. The Smuggler jig and table concentration mill at Aspen, a steady contributor

of silver concentrates in 1922, could not survive the decrease in price of silver in June and ceased operations in August. Shipments of smelting silver ore were continued throughout the year but in lessened quantity.

The shipments from Leadville in 1923 declined when silver dropped to the world price, and the pulling of the pumps on the lower levels of the Penrose mine in November, 1923, drove the work to the upper levels of the Down Town Co.'s property. The decrease in the number of lessees on the Yak property in November also cut down the shipments from this group of mines. The pumping of water begun at the Pyrenees and Greenback shafts late in September, 1923, for which preparations had been begun in May, was expected to run throughout 1924 and into 1925 before the Carbonate Hill and Graham Park mines could be reopened. The Golden Eagle, Fanny Rawlings, and Ibex mines continued to ship gold ores. The officers of the Canterbury drainage adit received money enough from sources at Leadville to maintain one shift a day in driving the heading, and the adit has already lowered somewhat the water in the Fryer Hill mines. A new flotation mill has been built at the Griffin mine, at Sugar Loaf. The Western Zinc Oxide Co.'s furnaces were operated steadily on low-grade zinc carbonate ores, and the Leadville District mill was remodeled to concentrate the coarsely disseminated pyrite from the highly siliceous porphyry gangue of the South Ibex ores. The Cary-McClain selective-flotation mill was built and operated for a time on low-grade lead-zinc ores. The Derry Ranch dredge, in Box Creek, was placed in operation in July and yielded gold bullion for several months. Kokomo, Summit County, shipped pyrrhotite silver ores as long as silver brought $1 an ounce and contributed also some zinc and lead concentrates from desultory operations.

The mines in Gunnison County, which have been rather inactive for several years, made an output in 1923 of gold bullion and concentrates from the Carter mine, at Ohio City; of lead-zinc ore from the Akron mines, at Whitepine; and of arsenic ores from the White Iron mine, at Madera siding, south of Sapinero.

In Chaffee County lessees made shipments of ore from the Mary Murphy mine, at Romley, and from the Lilly, Giant Eclipse, and Madonna, at Monarch.

In Custer County considerable lead-silver ore was shipped from the Passiflora mine, at Westcliffe; the cyanide mill on the Bassick dump, at Querida, was completed and operated for a short time; and the 200-ton concentrating mill at the Terrible mine, at Ilse, was operated full time.

The dredges and the hydraulic and sluice mines at Breckenridge yielded $203,379 in gold, as compared with $255,298 in 1922. From the Wellington mills zinc concentrates of relatively high grade were shipped steadily in 1923, whereas in 1922 shipments were made only during two months. The Wellington mill also yielded iron-silver and lead-silver concentrate. Lead-silver ores were shipped direct to the smelter at Leadville from Breckenridge.

Operations at the London mine, on Mosquito Pass, Park County, produced high-grade gold smelting ore, and a flotation-cyanidation mill was under construction to treat London low-grade ores. The

Magnolia mill produced gold bullion for a time, and several cars of high-grade gold ore were shipped from the reopened Orphan Boy mine. The Fairplay dredge continued throughout the year regular shipments of gold bullion to the Denver Mint.

Small shipments of lead-silver ore were made from Montezuma, Summit County. Across Loveland Pass, in Clear Creek County, the Silver Plume or Gold Belt adit, driven from the south side of Clear Creek southward into Mount McClellan, 3 miles west of Silver Plume, cut a fissure vein of lead-silver-zinc ore, from which was cobbed several hundred tons of relatively high-grade silver smelting ore and several hundred tons of lead-zinc-silver milling ore. The discovery of this vein adds a new property and practically a new mining district to the State of Colorado, although the Belmont mine, on the south side of Mount McClellan, was the first paying silver mine in the State, later followed by the Waldorf and Santiago mines, on the south side of the mountain, and the Stevens mine, on the west side. In the Georgetown-Silver Plume district the East Butte, Wasatch-Colorado, Watrous (S. P.), Capital, Sceptre-Sunburst, and St. George mills were operated during part of the year. The production at Idaho Springs was small, but some development work was done. There was some production from the Montana (Lawson-Dumont) and Trail districts. Gilpin County mines made a very small output in 1923.

Boulder County contributed gold ore from the Logan and Wood Mountain mines and silver ore from the Yellow Pine and Caribou mines.

Mine production of gold, silver, copper, lead, and zinc in Colorado in 1923

County	Producing mines	Ore sold or treated (short tons)	Gold •		Silver •	
			Fine ounces	Value	Fine ounces	Value
Adams	1	----------	16.50	$341	3	$2
Boulder	44	1,960	1,313.19	27,146	39,556	32,436
Chaffee	7	2,173	825.91	17,073	20,762	17,025
Clear Creek	51	23,464	1,479.12	30,576	183,874	150,777
Custer	8	51,200	122.68	2,536	28,484	23,357
Dolores	10	1,393	139.79	2,890	39,408	32,315
Eagle	8	98,427	2,018.88	41,734	322,143	264,157
Fremont	1	44	1.31	27	184	151
Gilpin	38	5,631	1,412.35	29,196	44,942	36,852
Grand	1	2	----------	----------	323	265
Gunnison	4	11,019	1,153.94	23,854	24,939	20,450
Hinsdale	5	684	35.41	732	30,046	24,638
Lake	69	115,975	13,134.01	271,504	655,838	537,787
La Plata	8	838	769.40	15,905	17,138	14,053
Mineral	8	6,462	115.81	2,394	228,867	187,671
Montrose	2	101	8.56	177	10,523	8,629
Ouray	11	87,260	2,864.14	59,207	840,044	688,836
Park	11	471	7,809.76	161,442	18,701	15,335
Pitkin	17	58,641	----------	----------	429,581	352,256
Rio Grande	2	17	80.40	1,662	161	132
Saguache	5	34,456	204.58	4,229	155,723	127,693
San Juan	16	153,114	11,706.07	241,986	471,750	386,835
San Miguel	15	484,064	66,465.70	1,373,968	1,606,344	1,317,202
Summit	27	48,965	11,418.53	236,042	142,548	116,889
Teller	48	382,739	195,774.01	4,047,008	22,606	18,537
	417	1,569,100	318,870.05	6,591,629	5,334,488	4,374,280
Increase or decrease from 1922	−63	+157,000	+10,555.90	+218,210	−521,423	−1,481,631

• Includes placer production of $364,429 in gold and of 4,122 fine ounces of silver valued at $3,380.

Mine production of gold, silver, copper, lead, and zinc in Colorado in 1923—Contd

County	Copper		Lead		Zinc		Total value
	Pounds	Value	Pounds	Value	Pounds	Value	
Adams							$343
Boulder			26,729	$1,871			61,453
Chaffee	7,089	$1,042	557,429	39,020	132,000	$8,976	83,136
Clear Creek	32,218	4,736	1,016,729	71,171	577,000	39,236	296,496
Custer	11,436	1,681	2,890,328	202,323			229,897
Dolores	56,823	8,353	162,414	11,369	138,000	9,384	64,311
Eagle	632,565	92,987	460,171	32,212	23,600,000	1,604,800	2,035,890
Fremont			1,999	140	20,000	1,360	1,678
Gilpin	22,884	3,364	230,157	16,111			85,523
Grand			314	22			287
Gunnison	1,788	263	1,690,430	118,330	2,889,000	193,452	359,349
Hinsdale	10,075	1,481	19,971	1,398			28,249
Lake	511,776	75,231	5,624,958	393,747	9,415,000	640,220	1,918,489
La Plata	816	120	1,800	126			30,204
Mineral	1,088	160	237,557	16,629	41,000	2,788	209,642
Montrose	17,857	2,625					11,431
Ouray	44,197	6,497	1,538,027	107,662			862,202
Park	5,558	817	19,401	1,358			178,952
Pitkin			2,972,614	208,083	465,000	31,620	591,959
Rio Grande	218	32	929	65			1,891
Saguache	459,477	67,543	2,919,200	204,344			403,809
San Juan	1,005,441	147,800	10,738,943	751,726	9,540,000	648,720	2,177,067
San Miguel	1,408,980	207,120	10,695,814	748,707			3,646,997
Summit	17,823	2,620	3,892,271	272,459	7,335,000	498,780	1,126,790
Teller							4,065,545
	4,248,109	624,472	45,698,185	3,198,873	54,152,000	3,682,336	18,471,590
Increase from 1922	874,655	169,056	22,220,985	1,907,627	30,894,000	2,356,630	3,169,892

REVIEW BY COUNTIES[1]

ADAMS COUNTY

The special placer gold-saving apparatus installed at the gravel-screening plant where the Federal Boulevard crosses Clear Creek continued to recover "flour" gold from gravel containing about 3 cents a yard. The bullion recovered in 1923 averaged 0.848 in fineness of gold and 0.146 in fineness of silver.

BOULDER COUNTY

Central district.—The Central district, near Jamestown, produced 37 tons of ore carrying $925 in gold, 511 ounces of silver, and 2,702 pounds of lead, having a total value of $1,533, as compared with $3,159 in 1922. The production was the result of intermittent operations by lessees, who shipped small lots from six properties. Some of this ore was taken out in the mining of fluorspar.

Gold Hill district.—The Gold Hill district produced 56 tons of ore, carrying $1,687 in gold, 1,639 ounces of silver, and 515 pounds of lead, having a total value of $3,067, as compared with $14,201 in 1922. Of the 10 producing properties the principal mines were the Emancipation and the Goldsmith Maid.

Grand Island district (Cardinal, Caribou, Eldora, and Nederland).—The Grand Island district produced 870 tons of ore, carrying $1,878 in gold, 26,095 ounces of silver, and 11,270 pounds of lead, having a

[1] For production by counties see table, p. 623.

total value of $24,065, as compared with $48,453 in 1922. The Caribou mine, on which several sets of lessees worked part of the year and shipped high-grade silver smelting ore in small lots, produced the bulk of the output of the district. Other producing mines were the Boulder County, Grant County, Congo Chief, Golden Reward, St. Louis, and Sweet Home. The Boulder County mill, many years ago a stamp-amalgamation mill and later a tungsten-concentrating plant, was completely remodeled, with the addition of concentrating tables and flotation cells. It was operated with some success on ore from the Boulder County mine for a month and then forced to close because of legal difficulties.

Magnolia district.—Several small lots of ore from the Magnolia district, aggregating 24 tons, carrying $2,231 in gold and 22 ounces of silver, were purchased by the Boulder sampler.

Sugar Loaf district.—The Sugar Loaf continued to be the largest producing district in Boulder County, 14 mines making an output of 945 tons of ore, carrying $19,721 in gold, 9,656 ounces of silver, and 3,271 pounds of lead, with a total value of $27,868, as compared with $83,020 in 1922. Lessees on the Yellow Pine mine shipped small lots of relatively high-grade silver smelting ore to the Boulder sampler. Lessees on the Logan mine continued to ship specimen gold to the Denver Mint and small lots of high-grade gold ore to the Boulder sampler and to the Golden Cycle mill. Several small lots of gold ore were shipped from the Nancy group. The Red Signe mine, formerly a tungsten producer, shipped several cars of gold ore to the Golden Cycle mill. The development work of the last several years at the Wood Mountain mine resulted in shipments of gold ore to the Golden Cycle mill and late in the year the placing in operation of the 75-ton amalgamation-concentration mill on the property.

Ward district.—The Ward district produced only 28 tons of ore, carrying $704 in gold, 1,633 ounces of silver, and 8,971 pounds of lead, with a total value of $2,671, as compared with $10,618 in 1922.

CHAFFEE COUNTY

Chalk Creek district (Romley).—Lessees on the upper levels of the Mary Murphy group shipped a car of zinc-lead sulphide ore and several hundred tons each of lead-silver-gold sulphide and oxidized ores.

Granite district.—Placer gold bullion averaging 0.840 in fineness of gold and 0.156 in fineness of silver was sluiced from the Twin Lakes placer.

La Plata district.—A 1-ton lot of lead-silver ore was shipped from the Banner mine, southwest of Granite.

Middle Cottonwood Creek district.—One car of sulphide lead-silver ore was shipped from the Gladstone mine.

Monarch-Garfield district.—Oxidized ores carrying lead, silver, and gold were shipped from the Lilly group and from the Madonna mine to the A. V. smelter, Leadville, and oxidized zinc ore was shipped from the Little Giant-Eclipse group to the Empire Zinc Co., Canon City, and to the Western Zinc Oxide Co., Leadville.

CLEAR CREEK COUNTY

Alice district (Yankee, Lincoln).—Several tons of gold ore from the Champion property was treated in the Reynolds stamp amalgamation mill.

Argentine district.—Development work for many years resulted in 1923 in what promises to be a new mine in the Argentine district. The Gold Belt tunnel, driven into Mount McClellan from Clear Creek, 3 miles above Silver Plume, opened a vein of silver-lead and silver-lead-zinc ore, from which several hundred tons of relatively rich silver ore was shipped to the Idaho Springs sampler and direct to the Leadville smelter, and several hundred tons of lead-zinc-silver ore to the Watrous concentrating mill at Silver Plume. The products of milling were lead concentrate, dry silver concentrate, and zinc concentrate. A car of copper-gold-silver ore was shipped from the Santiago mine.

Empire district.—Several narrow-gage cars of gold-silver ore from the Empress Tunnel property was concentrated at Idaho Springs. A car of sulphide gold ore was shipped to the A. V. smelter, Leadville, from the Silver Mountain mine.

Griffith district (Georgetown, Silver Plume).—Eleven mines in the Georgetown-Silver Plume district produced 17,446 tons of ore, yielding $5,093 in gold, 68,923 ounces of silver, 6,061 pounds of copper, 659,743 pounds of lead, and 539,700 pounds of zinc, with a total value of $145,383, as compared with $209,169 in 1922. The East Butte Copper Co. continued for part of the year the milling started in 1922 of the dumps of the Diamond, Pelican, and Zero adits. The product was a lead concentrate carrying a relatively high content of silver. The Silver Plume Silver Mines Co. completed its 75-ton gravity-concentration and oil-flotation mill across Clear Creek from the Terrible mill and an aerial tram to the Mammoth mine dump, from which several hundred tons was sorted and milled with a product of zinc-silver and lead-silver concentrates. The Mendota mill was operated on lead-zinc-silver ore from the Mendota-Frostburg mine, producing lead-silver and zinc-silver concentrate. The Sunburst mill was operated for a time on dry silver ores from the Sceptre-Sunburst group. The St. George mine and gravity-concentration and oil-flotation mill were operated for a time. The Capital gravity-concentration and oil-flotation mill was operated for a short time. Several cars of lead-silver smelting ore were shipped from the Backbone mine.

Idaho Springs district.—In the Idaho Springs district 26 mines produced 2,535 tons of ore, carrying $15,239 in gold, 14,422 ounces of silver, 5,021 pounds of copper, and 162,314 pounds of lead, with a total value of $39,165, as compared with $92,049 in 1922. The year was probably the quietest Idaho Springs has ever experienced. The Gem mines and mill, which have usually supplied the bulk of the production, were operated for a short time only. The Hudson amalgamation and concentration mill was operated for a time. Small lots of ore were mined from the Almaden, Argo (Ute Creek), Edgar, Crown Point, Gem, Golden Edge, Lincoln, Little Mattie, Queen Elizabeth, Treasure Vault, and Tropic.

Montana district (Lawson, Dumont).—The Montana district from 7 mines produced 764 tons of ore, yielding $2,702 in gold, 20,745 ounces of silver, 5,558 pounds of copper, and 72,272 pounds of lead,

with a total value of $25,589. Small lots of milling and smelting ore were shipped from the Albro, Bellevue-Hudson, Big Chance, Jo Reynolds, Mattie Jack, Millington, and Tabor tunnel.

Trail Creek district (*Lamartine, Freeland*).—The Trail Creek district produced 1,244 tons of ore, yielding $5,916 in gold, 2,029 ounces of silver, 11,041 pounds of copper, and 35,900 pounds of lead, with a total value of $11,716, as compared with $3,648 in 1922. The principal producing mine was the Freeland, from which both smelting ore and milling ore were mined.

CONEJOS COUNTY[2]

Because of the inaccessibility of the ore deposits of Conejos County, nothing but assessment work has been done on them for many years. There are said to be some large bodies of low-grade gold ore in the county.

COSTILLA COUNTY[3]

No work of any kind was done in the mining districts of Costilla County. In the Grayback district, north of Russell, there are some gold placer areas and undeveloped bodies of low-grade gold ore. In the El Plomo district, on Rio Seco, northeast of San Luis, there is said to be a large low-grade gold deposit in quartzite, suitable for quarrying.

CUSTER COUNTY

Smelting ores, valuable chiefly for their silver content but also carrying lead and copper, were shipped from the Lady Franklin, Maxine Elliot, Passiflora, and Ten-to-One properties, near Westcliffe. One car of lead-silver ore was shipped from the Little Annie claim, near Rosita. The Alaska Mining & Milling Co. continued the remodeling of the Bassick cyanidation plant, brought the electric power line from Ilse, 8 miles distant, and operated the mill for a time on material from the Bassick dump. The cyanide bullion contained 13.2 parts of silver by weight to 1 of gold. The jig and table concentrating mill at the Terrible mine, at Ilse, with a capacity of 200 tons in 24 hours, was operated practically full time the entire year. This mill treats a low-grade cerusite ore, making a product of 70 per cent lead concentrate.

DOLORES COUNTY

Dunton district.—A car of silver smelting ore of relatively high content was shipped from the Emma mine.

Pioneer district (*Rico*).–A car of lead-zinc ore was shipped to Blende, Colo., from the Bancroft mine. A small lot of silver-copper ore was shipped to the Durango smelter from the F. V. G. mine. The Rico Wellington Mining Co. reported the opening of 800 feet of drifts, crosscuts, and raises at the General Sheridan mine and shipments of

[2] For geology and description of mines at Platoro, Gilmore, and Stunner, see Patton, H. B., Geology and ore deposits of the Platoro-Summitville mining district, Colo.: Colorado Geol. Survey Bull. 13, 1917. See also Rio Grande County.

[3] For description of geology, see Patton, H. B., and others, Geology of the Grayback mining district, Costilla County, Colo.: Colorado Geol. Survey Bull. 2, 1909; also Van Diest, E. C. and P. H., Notes on the geology of the Sangre de Cristo Range: Colorado Sci. Soc. Proc., vol. 5, pp. 76–85, 1894.

500 tons of lead-silver ore to the Durango smelter. Several hundred tons of silver-copper ore and nearly 200 tons of zinc-lead ore were shipped from the Falcon group. A car of lead-silver and several cars of zinc-lead ore were shipped from the Syndicate mine. Several cars of lead-silver ore were shipped from the Yellow Jacket mine.

EAGLE COUNTY

Battle Mountain district (*Red Cliff, Gilman*).—A very large quantity of pyrite ore, carrying a relatively low content of silver, some copper, lead, and gold, was shipped from the Eagle mines of the Empire Zinc Co. to the Garfield and Murray smelters, in Utah. In addition, a large quantity of zinc-iron-lead sulphide ore from these mines was moved to Canon City, Colo., for concentration by magnetic separation into high-grade zinc concentrate for roasting to zinc oxide, a low-grade zinc concentrate, and a pyritic lead-silver-gold concentrate. Other producing mines were the Ben Butler, Foster Combination, Ground Hog, Pursey Chester, Silurian, Sulphide Lease, and others. Several cars of iron-manganese ore were shipped to the Colorado Fuel & Iron Co., at Pueblo, from the J. Best claim.

Brush Creek district (*Eagle*).—Very little work was done in 1923 in driving the adit to cut the Lady Belle-North Dakota group at depth.

EL PASO COUNTY

At Colorado Springs the Golden Cycle 1,200-ton roast-amalgamation and cyanidation mill was operated steadily but not at full capacity, chiefly on the gold ores from the Cripple Creek district and small lots of gold ore from Boulder County. The Cresson mine, in the Cripple Creek district, continued to contribute about half of the ore treated at the Golden Cycle mill.

FREMONT COUNTY

At Canon City the Empire Zinc Co.'s magnetic separation plant was steadily operated on zinc-iron sulphide ore from its Eagle mines at Gilman, Eagle County, and its zinc oxide plant was operated on concentrates from the magnetic separating mill, concentrates from Hanover, N. Mex., and some zinc carbonate ore from Leadville. At Florence the River Smelting & Refining Co.'s matting and fuming plant was operated until November 1. A car of zinc concentrates from previous milling operations at the Cotopaxi mine, at Cotopaxi, was shipped in 1923.

GILPIN COUNTY

Southern districts (*Black Hawk, Central City , Nevadaville, Russell Gulch*).—The Polar Star custom amalgamation mill, at Black Hawk, was operated intermittently. The Midwest mill was operated only a short time and only on company ores. Some Gilpin County milling ores were hauled to Idaho Springs for treatment.

No ore was shipped from mines within the town limits of Central City.

In the Enterprise district, below Black Hawk, dry gold ore was shipped to the smelter, and milling gold ore was amalgamated and

concentrated from the Waine group. Silver and lead-silver ore was shipped to smelters from the Champion, Black Jack, and Wheeler.

In the area embracing Gunnell Hill and Eureka and Prosser gulches several cars of lead-silver-gold ore were shipped direct to the Leadville smelter, and milling gold ore from the Rara Avis mine was concentrated into lead-gold-silver concentrate.

In the area embracing the town of Black Hawk and Gregory, Bobtail, and Bates hills 165 tons of gold ore from the Dump lode was treated in a new 10-stamp amalgamation mill on the property, and operations were then abandoned. Other producing mines were he Etna, Mary Miller, Lucky No. 2, Thanksgiving, and Senator.

In the Hughesville-Hawkeye district, north of Black Hawk, the Midwest 100-ton gravity-concentration and oil-flotation mill was operated for a short time on low-grade silver ore from the Cyclops group. Several hundred tons of lead-silver ore was mined from the Atlantic prospect, and several cars of lead-silver ore from the Coyle prospect.

In the Nevada district 100 tons of gold ore from the Columbia tunnel (Argo claim of Kansas Burroughs group) was treated by amalgamation and concentration, and two cars of gold ore were shipped to the A. V. smelter. Mining from the Newhouse (Argo) adit level at the Ophir-Burroughs mine was abandoned in January, 1923.

In the Quartz Valley district several lots of milling ore were mined from the Greenside, Spur Daisy, and Margaret Glennon.

In the Russell Gulch district several cars of smelting silver ore were shipped from the Druid mine; milling gold ore was mined from the Fairfield-Morning Star group; both milling and smelting gold ores were mined from the Jupiter-St. Clair group; milling gold ore from the Davis; and smelting gold ore from the Saratoga and Two Forty.

Northern district.—In the Silver Creek district, near Apex, the amalgamation-concentration mill on the Reform Lode group was operated for six months.

Near Rollinsville the Colorado-Penobscot group produced gold ore, which was milled in a concentrating mill on the property. The Smuggler amalgamation mill was operated for a time.

GRAND COUNTY

A 2-ton lot of relatively high-grade silver-lead ore was shipped from the Ready Cash mine, in the La Plata district.

GUNNISON COUNTY

Domingo district.—The Good Hope mine was unwatered to the 600-foot level during the year.

Goose Creek district (*Madera*).—Several hundred tons of arsenic ore was shipped from the Goose Creek district to the Globe plant, Denver. No settlement was made for the silver in this ore.

Gold Brick district (*Ohio City*).—At the Carter mine 700 feet of drifts and 100 feet of raises were opened, and 3,300 tons of gold ore was milled in the company's 20-stamp amalgamation-concentration mill.

Quartz Creek district (*Pitkin*).—A car of silver ore was shipped to the A. V. smelter, Leadville, from the Maid of Athens group.

Whitepine (Tomichi) district.—The mill at the Akron mines was not operated in 1923, but 7,600 tons of zinc-lead sulphide ore was shipped to leaded-zinc pigment plants. Lead-zinc sulphide ore from the Victor mine was shipped to leaded-zinc pigment plants, and lead sulphide ore to lead smelters.

HINSDALE COUNTY

The production of metals from Hinsdale County in 1923 decreased heavily.

Cimarron Creek district.—Toward the development of the Silver Jack mine 7 miles of road was built, and rock and dirt cuts were made for 1,180 feet of pipe line.

Galena district.—The producing mines in the Galena district were the Cleveland, Fanny Fern, and Ute. The ore from the Cleveland averaged 60 ounces of silver to the ton. Several hundred tons of silver ore from the Fanny Fern mine was shipped to the Leadville smelter. A custom concentrating mill was built at Lake City in October, but after treating some of the low-grade ore from the Fanny Fern and Belle of the East mines it was destroyed by fire in December. At the Golconda mine, above Rose's cabin, 1,000 feet of development work was done. Some development work was also done at the Lellie mine.

Lake district.—Several cars of relatively high-grade silver-copper ore were shipped from the Belle of the West and Belle of the East mines. About 100 tons of low-grade silver ore from the Belle of the East mine was concentrated at the short-lived custom mill at Lake City. At the George III mine 400 feet of drifting was done.

JACKSON COUNTY

The Wolverine mine, near Cowdrey, from which copper ore was shipped in 1917–18, continued idle in 1923. Shipments of fluorspar were made from North Gate.

LAKE COUNTY

In Lake County there was a material decrease in production of all metals except lead and zinc, and the gross value fell from $2,299,612 to $1,918,489. The Derry Ranch dredge was again in operation. The total quantity of ore shipped increased from 112,547 to 115,975 tons. This county ranked third in production of zinc, lead, silver, and gold and fourth in the production of copper.

LEADVILLE DISTRICT

GENERAL FEATURES

Of the 115,975 tons of ore mined in Lake County, 114,283 tons came from the Leadville district. The yield was 12,280.14 ounces of gold, valued at $253,853, 598,027 ounces of silver, 510,891 pounds of copper, 5,607,172 pounds of lead, and 9,390,000 pounds of zinc, and the total calculated value was $1,850,358, out of a county total of $1,918,489.

Classification of Leadville ores in 1923

	Ore		Recovered content				
	Percentage	Short tons	Gold	Silver	Copper	Lead	Zinc
Sulphide:			*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Siliceous (carrying sulphides) [a]	17	18,973	2,450.40	43,801	56,445	300,718	
Iron pyrites [b]	8	8,891	727.30	129,729	168,819	332,259	
Lead	2	2,405	441.90	73,176	26,239	395,233	
Copper (mostly excess silica over iron)	3	3,716	1,795.50	67,501	209,303	38,653	
Zinc-iron-lead	10	11,831	[c] 64.73	[c] 27,811		[d] 471,966	[e] 2,658,000
	40	45,816	5,479.83	342,018	460,806	1,538,829	2,658,000
Oxide (includes low sulphur ores):							
Siliceous gold	3	3,300	5,567.03	12,743	3,806	60,571	
Siliceous silver	17	19,021	9.60	67,428	5,005	1,080,195	
Lead (iron excess)	2	2,418	61.20	8,657		412,167	
Lead (silica excess)	10	11,345	831.60	77,212	41,274	2,079,163	
Iron-manganese-silver-flux	10	12,079	18.30	89,882		436,247	
Zinc	18	20,304					[e] 6,732,000
	60	68,467	6,487.73	255,922	50,085	4,068,343	6,732,000
Metal (sulphide and oxide) [f]			312.58	87			
	100	114,283	12,280.14	598,027	510,891	5,607,172	9,390,000

	Average recovery				
	Gold	Silver	Copper	Lead	Zinc
Sulphide:	*Ounces per ton*	*Ounces per ton*	*Per cent*	*Per cent*	*Per cent*
Siliceous (carrying sulphides)	0.129	2.31	0.15	0.79	
Iron pyrites	.082	14.59	.95	1.87	
Lead	.184	30.43	.55	8.22	
Copper	.483	18.16	2.82	.52	
Zinc-iron-lead	.006	2.35		[g] 2.74	[g] 14.04
Oxide:					
Siliceous gold	1.687	3.86	.06	.92	
Siliceous silver		3.54	.01	2.84	
Lead (iron excess)	.025	3.58		8.52	
Lead (silica excess)	.073	6.81	.18	9.16	
Iron-manganese-silver-flux	.002	7.44		1.81	
Zinc					[g] 20.72

[a] Much highly siliceous, and in all silica exceeds iron content. Partly gold and partly silver ore.
[b] Iron content exceeds silica content. A dry silver ore.
[c] Recovered in residues.
[d] Recovered in residues and in leaded zinc oxide.
[e] Zinc in terms of recovered zinc in zinc oxide and leaded zinc oxide.
[f] Probably includes some Teller County specimen gold.
[g] Average assay of original content; no deduction for loss in smelting. Wet assay of lead.

The A. V. smelter of the American Smelting & Refining Co., with eight furnaces, operated three furnaces throughout the year and four furnaces part of the year, entirely on Colorado ores and concentrates and a small quantity of zinc residues from Kansas-Oklahoma zinc retort furnaces. About half of the material came from Lake County, and one-fourth from Pitkin County (Aspen). Old slags from the old American, Bi-Metallic, and Elgin smelter dumps, containing lead and silver, helped maintain the smelter in operation. The Western zinc oxide plant, using entirely Leadville low-grade zinc oxide ores, was operated steadily. At the end of 1923 the Canterbury drainage adit was 2,140 feet long.

MINE REVIEW

The Down Town Mines Co., operating a large area chiefly through the Penrose shaft, continued operations steadily until October 31, when operations ceased and the pumps were pulled. Shipments consisted of lead-silver oxide ores, zinc oxide ores, iron-manganese-silver fluxing ores, and iron-manganese ores to steel plants. The iron-manganese ores to steel mills averaged when dried 20 per cent manganese, 24 per cent iron, and 8 per cent silica. The iron-manganese ores to the lead smelter averaged 18 per cent manganese, 28 per cent iron, and 13 per cent silica. From the A. V. mine iron-manganese ore to steel mills averaged 38 per cent manganese, 10 per cent iron, and 12 per cent silica. The Iron-Silver Mining Co. made no production on company account, but lessees shipped lead-silver oxide ore and zinc oxide ore. The Leadville Deep Mines Co., a consolidation for combined pumping and mining of the flooded Graham Park-Carbonate Hill area, including the Clontarf, Brookland, Wolftone, Mahala, Pyrenees, Mikado, Result, Robert Emmet, R. A. M., Cyclops, Gonabrod, Greenback, and others, began preparations for unwatering with specially designed electric pumps on May 10, 1923. The unwatering was expected to take all of 1924 to complete. During the four years of idleness the water level had risen from a depth of 1,400 feet below the surface to 600 feet. The Greenback and Pyrenees shafts were selected as the sites for the initial work and for pumping out the basin, as the Greenback was the deepest and most centrally located and the Pyrenees was the largest and best equipped and was known to be in first-class condition. The water level was found to be at an altitude of 10,080 feet, or 551 feet below the collar of the Greenback shaft, 590 feet below the collar of the Pyrenees shaft, and above any available station in either of the shafts. New pump stations had to be cut above the water at each of the shafts. While these stations were being cut the surface plants were overhauled and put in first-class condition for continuous operation and for handling the heavy pumping equipment to be lowered into the shafts. The pumps were started late in September and by December 28 had lowered the water 350 feet in the Greenback and 365 feet in the Pyrenees. This work uncovered the first level of the Greenback shaft at a depth of 900 feet below the collar, and the Greenback pumping unit will be moved down to that level and installed.

A selective-flotation mill was under construction by Cary & McClain during March and April in the Norton sampling-works building, on the site of the old Grant smelter at Front and Leiter streets. The plant was put in operation May 1 and was operated to August 1 and again in September on dump ore from the Adams and Maid of Erin dumps. The product consisted of zinc-lead-silver and lead-silver concentrates. Other operations (underground) on the Henriette-Maid of Erin produced lead-silver oxide, zinc oxide, and iron-manganese-silver oxide ores. From the Carbonate, Shamrock, and Little Giant claims lessees shipped iron-manganese-silver-lead oxide ores, the part averaging 19 per cent iron, 27 per cent manganese, and 15 per cent silica to the A. V. lead smelter and the part averaging 37 per cent manganese and 12 per cent silica to the Tennessee Coal, Iron & Railroad Co., Birmingham, Ala. The ore shipped to the lead

smelter was paid for on a basis of the market price for silver less a treatment charge, and that shipped to the steel furnaces was paid for on a basis of manganese content less penalties for too high silica with no payment made for silver and lead, and less freight to Birmingham. Siliceous lead-silver oxide ore and iron-manganese-silver ore averaging 10 per cent manganese, 22 per cent iron, and 34 per cent silica were shipped to the lead smelter from the Stars group. Zinc oxide ore was shipped from the Denver City, May Queen, and Small Hopes group (Forest City). Lead-silver oxide and sulphide ores and zinc oxide ore were shipped from the Little Chief group. Zinc oxide, siliceous silver oxide, and iron-manganese-silver oxide ores were shipped from the Robert E. Lee. Iron-manganese ore to steel mills from the Jason mine averaged when dried 16 per cent manganese and 37 per cent iron, that from the Fairview 21 per cent manganese and 32 per cent iron, and that from the Stars 18 per cent manganese, 24 per cent iron, and 10 per cent silica. Siliceous sulphide ore carrying gold and silver was shipped from the Little Vinnie claim. From the Ibex group was shipped the usual variety of ores, including lead-zinc-silver sulphide, iron-silver-gold sulphide, siliceous copper-silver-gold sulphide, siliceous lead-silver oxide, siliceous gold oxide, and zinc oxide ores. Also several tons of pyrite crystals was sold to radio-crystal manufacturers. In addition the low-grade gold ore of the coarsely disseminated pyrite ore body of the southern claims of the Ibex Co. and adjoining claims (Nonie, Garbutt, and Maud Hicks) was milled at the Leadville District gravity-concentration mill. Siliceous copper sulphide and iron-copper sulphide ore, carrying silver and gold, was shipped from the Fanny Rawlings. Iron-silver-gold-copper sulphide and lead-silver-copper sulphide ores were shipped from the Louisville, and lead-silver sulphide ore was shipped from the A. Y. and Minnie mine. Siliceous lead-silver ore was shipped from the Cleveland claim. Highly siliceous lead-silver-gold oxide ore was shipped from the Izzard claim. From the Reindeer dump of the Nisi Prius Co. was shipped lead-silver oxide ore, with combined iron and manganese content only slightly above that of silica. Some specimen gold ore and lead-silver-gold oxide ore, with excess of iron over silica, was shipped from the Lilian mine. Iron-manganese-silver ore with relatively high silica content was shipped from the Oro La Plata claim. Siliceous silver-lead-copper-gold sulphide ore, siliceous lead-silver oxide ore, pyritic silver ore with some lead and copper, lead-silver sulphide ore, and zinc-lead sulphide ore were shipped from the Famous, Dolly B, Polaris, Cord, and White Cap mines of the Yak Co.

OTHER DISTRICTS

St. Kevin, Sugar Loaf, and Independence districts.—Silver sulphide ore was shipped from the Consolidated Virginius and Dinero-Inez, lead-silver sulphide ore from the Fanchon Placer (a lode mine), and silver siliceous oxide ores from the Prince of Wales, St. Kevin, and Snow-Arty. At the Gerald-Griffin mine an oil-flotation mill was being built during the summer and fall.

Arkansas River placer districts.—The Derry Ranch dredge, in Box Creek, was operated from July 8 to December 1, under the name of the Mount Elbert Gold Dredging Co. This company controls 2,620 acres of placer ground.

LA PLATA COUNTY

La Plata County in 1923 produced gold, silver, and small quantities of lead and copper, with a total gross calculated value of $30,204, as compared with $42,917 in 1922. The principal producing mines were the Cumberland Co. (May Day claim), Jumbo, Lady Eleanor, Lucky Moon, Tomahawk, and Valley View Co. (Idaho claim).

MINERAL COUNTY

The output of silver from Mineral County mines (all near Creede) was more than twice that in 1922. The principal producing mines were the Amethyst, Bachelor, Commodore, Holy Moses, Mollie S, and New York-Last Chance-Volunteer. Fluorspar was shipped from Wagon Wheel Gap.

MONTROSE COUNTY

Lessees on the La Sal mines, on La Sal Creek, west of Bed Rock, shipped several carloads of relatively high grade copper ore, carrying also a relatively high content of silver. Sluicing on bench gravel 60 feet above the stream level of Dolores River, 25 to 30 miles below Naturita, yielded several ounces of placer gold averaging 0.792 in fineness of gold and 0.204 in fineness of silver.

OURAY COUNTY

Red Mountain district.—At the Barstow and Imogene mines a little development work and stoping in the spring and a short mill run in the summer produced a few tons of lead-silver-gold concentrates.

Sneffels district.—Four mines in the Sneffels district produced 86,861 tons of ore, yielding $56,242 in gold, 831,772 ounces of silver, 42,727 pounds of copper, and 1,485,784 pounds of lead, with a total value of $848,581, as compared with $1,366,732 in 1922. The Atlas mine produced ore in 1923 at about the same rate as in 1922, and the lead-silver-gold concentrates produced at the 200-ton 20-stamp and rod-mill gravity-concentration oil-flotation plant were approximately the same in quantity and grade as in 1922, but the return to the domestic price for silver by the smelters as the expiration of the $1 price fixed by the Pittman Act drew near, in June, heavily cut the receipts for the last part of 1923. The quantity of ore mined at the Humboldt mine and the average content to the ton were less than in 1922. This silver ore continued to be milled at the Smuggler Union mill, at Telluride, but the ore treated and the content recovered are credited to Ouray County. The Mountain Top mine was operated 334 days, and the mill 197 days. The ore, which is dry and siliceous, is first hand sorted and then crushed, then part of the lead-silver sulphide is caught on roughing concentration tables, part is saved in flotation cells, and the tailings go to the creek. The content of metals saved in 1923 was about the same as in 1922, but the lower average price for silver cut the receipts heavily. Several cars of silver-lead ore were shipped from the Revenue Tunnel group before August 1, when the work of recleaning and retimbering the property ceased.

Uncompahgre district.—Four mines in the Uncompahgre district produced 239 tons of ore, yielding $2,668 in gold, 7,695 ounces of silver, 1,470 pounds of copper, and 31,127 pounds of lead, having a

total value of $11,373, as compared with $67,955 in 1922. Small shipments of smelting ore were made from the American Nettie, Bachelor-Khedive, Bright Diamond, and Wedge.

PARK COUNTY

Buckskin Gulch district.—The Buckskin placer, equipped with four hydraulic giants, under a head of 132 feet, supplied by a ditch 1½ miles long, including 1,500 feet of pipes and 800 feet of flumes, was idle in 1923. Development work at the Sweet Home mine opened up silver-lead-copper ore, shipments of which began in 1924.

Consolidated Montgomery district.—Several lots of gold ore from the Magnolia mine were amalgamated in a small ball mill, called the Eddy mill, 6 miles north of Alma. Development work at the Russia group resulted in the shipment of several cars of silver ore from the Occidental and Hoosier claims.

Fairplay district.—The dredge of the South Park Dredging Co., completed in the stream bed of South Platte River below Fairplay on May 21, 1922, and operated continuously since, in 1923 handled 1,688,415 cubic yards of gravel, from which was recovered 6,975 fine ounces of gold and 1,437 fine ounces of silver, for which the company received $145,289, an average of 8.6 cents to the yard. The dredge is equipped with 70 buckets of 9 cubic feet each, and the daily capacity in 24 hours is 4,650 cubic yards.

Hall Valley district.—From the La Clede-Missouri group silver ore, carrying also a fair content of gold and varying quantities of copper and bismuth, was shipped. For part of the ore the bismuth content was also made a basis of settlement.

Horseshoe district.—No work was done in the Horseshoe district, formerly a relatively large producer of lead, silver, and zinc.

Mosquito district.—Several cars of gold ore were shipped from the Butte mine. One car each of lead-silver-gold ore was shipped from the Hock Hocking mine and from the Mosquito group. A car of gold ore was shipped from the Orphan Boy mine. Company operations on the London mine resulted in the shipping of several cars of high-grade gold ore. Lessees on that part of the London known as the South London level to the surface were engaged during the summer, fall, and winter in development work and in remodeling and rebuilding the London mill into a 60-ton oil-flotation and cyanidation mill. The mill when completed will be equipped with one 100-ton Blake crusher, one 60-ton Marcy ball mill, one Dorr classifier, six flotation cells, two Dorr agitation tanks, five Dorr thickening tanks, and one Portland filter. The ore will first be treated by flotation, and the tailings will be cyanided.

Tarryall district.—A small quantity of placer gold was panned from gravel in Tarryall Creek above Como. On Tarryall Creek below Como a drag-line scraper and patented fine-gold amalgamator was tried out.

PITKIN COUNTY

The mines of Pitkin County produced at about the same rate as in 1922 until shortly after the smelters anticipated the end of the payment of the fixed price of $1 an ounce for silver under the Pittman Act. The smelters took ore after April and May only on provisional settlement.

Aspen district (*Roaring Fork*).—The Smuggler 400-ton jig and table concentration mill, which was idle in 1921, ran steadily from May, 1922, to August, 1923, producing from low-grade silver ore (with some lead) a considerable quantity of marketable silver-lead concentrate, low in silica, iron, and sulphur, the remainder including lime and barite. In addition, lessees on various properties held by the Smuggler Leasing Co. shipped a large quantity of dry silver ore, also low in lead, iron, silica, and sulphur, and several thousand tons of higher-grade silver ore, low in sulphur but carrying more lead, iron, and silica than the dry ore. The Hunter Creek concentration mill, equipped also with flotation machines, was operated for a time by the Aspen Mines Co. on ore from the Bushwhacker, Alpine, and Della S properties, and some ore from these properties was also treated at the Smuggler mill on a custom basis. Dry silver ore, low in silica, iron, and sulphur but fairly high in lime (as CaO), was shipped from the B. C. W. (or Aspen Fraction), Millinee, Spar, and Smuggler Leasing Co. group. The Park Tunnel Mining & Milling Co. shipped dry silver ore, low in iron and sulphur but fairly high in silica, from the Jenny Lind group. From the Hope Tunnel group only one car of lead-silver ore was shipped. From the Newman Tunnel group was shipped a considerable quantity of lead-silver ore, low in iron and sulphur but in comparison with other Aspen ores relatively high in silica. At the Hurricane adit, about 1,000 feet long, south of Aspen, 150 feet of drifts were opened in 1923. The Midnight Mining Co., which has a large area under lease 9 miles south of Aspen, extended its main adit to 1,500 feet in the spring and during the remainder of the year dewatered and cleaned the 500-foot shaft and some of the 1,000 feet of drifts on the property.

Lenado district (*Woody*).—The Smuggler Leasing Co. drove the Aspen Contact adit 400 feet and the Link adit 100 feet in the development of the region north of Aspen, on Woody Creek, where some encouraging discoveries were made in 1920–21.

Meredith district (*Dry Pine*).—The Aspen Silver Lead Mines Co. continued development work on claims 12 miles north of Aspen, in a region that bears resemblance to that of the Blue limestone and White porphyry at Leadville.

RIO GRANDE COUNTY

Lessees on the Golconda mine, in the Summitville district, shipped one small car of gold ore to the Leadville smelter. A small specimen lot of gold ore was shipped from the Miser-Guadalupe group.

ROUTT COUNTY

The Hahns Peak Gold Mining & Milling Co. was diamond drilling below the main adit level during the summers of 1922 and 1923.

SAGUACHE COUNTY

Saguache County's production for 1923 was the largest in the history of the county, except that for 1894.

Kerber Creek district (*Bonanza*).—The Colorado Corporation completed its table and oil-flotation concentration mill at the Rawley mine, at Bonanza, July 1, 1923, and shortly afterward began shipping

lead-copper-iron-silver concentrate over the 7½-mile aerial tramway to Shirley station, on the Salida-Montrose branch of the Denver & Rio Grande Western Railroad. The mill is equipped with an Allis-Chalmers gyratory crusher, a Hummer screen, a set of Anaconda rolls, a Hardinge ball mill, 2 Dorr classifiers, 16 Deister Plat-O tables, 3 Allen 40-foot flotation cells, an 8-foot American filter, a Dorr thickening tank, conveyors, elevators, etc. The mine and mill were closed December 1 because of a change in the character of the ore. The mine is opened by an adit 6,600 feet long, a vertical shaft 845 feet deep, and 4,975 feet of drifts. In 1923 the development work consisted of opening 310 feet of drifts and preparing stopes for mining. This mine is one of the few in Colorado that has at least part of its ore body blocked out. Several cars of lead-copper-silver ore were shipped from the Cocomongo mine. In September the Kerber Creek Mining Co. was incorporated to purchase the Cocomongo group and to build a mill on the Bonanza claim. Work began on the mill in 1923. Several cars of lead-silver ore were shipped from the Baltimore and Rico-St. Louis groups. Dry silver ore having a relatively high content of silver, in a gangue of quartz and oxidized iron and manganese, was shipped from the Essie mine. The ore as shipped was highly siliceous.

Orient district.—The Orient iron mine, formerly a large producer of iron ore, was reopened by the Colorado Fuel & Iron Co., development work was done, and several thousand tons of ore was shipped to the steel plant at Pueblo.

SAN JUAN COUNTY

San Juan County, in which the mines were idle most of 1922 or not reopened until late in the year, made one of the smallest outputs in its history in that year, but in 1923 the gross calculated value of the output placed San Juan County third in the list of Colorado counties. A great part of this output in 1923 came from one mine, the Sunnyside.

Animas district.—Thirteen mines in the Animas district produced only 3,857 tons of milling and smelting ore, as against 6,761 tons in 1922. A lessee operated the Iowa-Gold Tiger mine and 100-ton gravity-concentration and oil-flotation mill for a short time. The Little Nation mine and 50-ton gravity-concentration and oil-flotation mill were also operated for a short time. Other producing mines were the Aetna, Diamond, Dives, Fredericka, Highland Mary, Little Maud, Philadelphia, Pride of the West, Queen City, and Silver Lake.

Eureka district.—Part of the Gold King 80-stamp concentration mill was operated during December only. During November the mill was remodeled. The Sunnyside mine and 500-ton selective-flotation mill were operated throughout the year. The ore belongs in the lead-zinc class, the products being lead and zinc concentrate, but the zinc concentrates carry considerable silver and lead and appreciable quantities of gold, so the residues are saved from the zinc retort furnaces. The lead concentrates are fairly high in lead percentage and also carry gold equal to the average content of Cripple Creek ores and a relatively high content of silver, as well as some copper.

SAN MIGUEL COUNTY

The gross calculated value of gold, silver, copper, and lead produced from mines in San Miguel County in 1923 showed an appreciable increase over the value in 1922.

Iron Springs district (Ophir).—Eight mines in the Iron Springs district produced 9,077 tons of ore, carrying $3,404 in gold, 68,807 ounces of silver, 36,660 pounds of copper, and 708,669 pounds of lead, with a total value of $114,822, as compared with $126,598 in 1922. At the Carbonero mine, opened by an adit 4,000 feet long and 3,800 feet of drifts, 500 feet of drifts were made in 1923, and 1,000 tons of lead-silver-copper ore was shipped to Durango, averaging 35.5 ounces of silver to the ton and 30 per cent lead. On November 26 this mine was taken over by the Ophir Colorado Mines Co., which plans to build a 50-ton oil-flotation mill. Siliceous sulphide ore (considerably oxidized) from the Butler vein of the Silver Bell mine above the sixth level (800 feet above the mill-level adit), was milled during the first six months of 1923 in the 80 to 100 ton gravity-concentration and oil-flotation mill. This mill is equipped with fifty 1,000-pound stamps, but only twenty were used. After July 1 milling ceased, and during the remainder of the year 542 feet of drifts were opened westward on the mill-level adit and 110 feet of stope raises as development work to open up the block of ground below the sixth level. The lower levels show siliceous sulphide ore without a trace of oxidation. The mill-level adit is 2,800 feet long and is connected with the upper levels by an 800-foot raise. There were also 75 feet of drifts opened on the Ida vein of the Silver Bell mine, and some hand-sorted ore was shipped. Other producing mines were the Butterfly-Terrible, Carribeau, Crown Point, Deadwood, and San Bernardo. Neither the Butterfly-Terrible mill nor the San Bernardo mill was operated. The Summit or Suffolk group was idle, but the 60-ton 20-stamp amalgamation, gravity-concentration, and oil-flotation mill was used to test some ores from the Carbonero mine.

Lower San Miguel district—Warren Simmons, of Sawpit, shipped a car of iron-manganese-silver-gold ore from dumps of old properties worked 40 years ago north of the town of Sawpit.

Upper San Miguel district—Five mines in the Upper San Miguel district produced 474,971 tons of ore, carrying $1,370,461 in gold, 1,537,358 ounces of silver, 1,372,320 pounds of copper, and 9,986,866 pounds of lead, with a total value of $3,531,906, as compared with $3,075,675 in 1922.

The Belmont Wagner Mining Co., operating the Alta mines, continued to run its 150-ton gravity-concentration and oil-flotation mill steadily until October, when it was found that the domestic price paid for silver after the expiration of the Pittman Act, on June 2, was insufficient to make the lead-silver-gold concentrate product yield a profit. During 1923 this company drove 846 feet of drifts, 88 feet of raises, and 1,629 feet on the heading of the Black Hawk adit. The Smuggler Union mine and mills were operated 362 days. The mills of this company, a 60-stamp amalgamation-concentration mill and a new 850-ton flotation plant, were used to treat the Smuggler Union, Humboldt, and Black Bear ore. The Smuggler Union and Humboldt ore was first amalgamated, but the Black Bear ore was first run over tables to make a high-grade lead product, and the

overflow went to the flotation machines where a zinc-lead-copper-iron-silver-gold concentrate was made. This complex concentrate was then moved to Durango for storage and special treatment in the Reed-Coolbaugh sulphating and leaching plant at the Durango smelter, where the zinc was first removed and the roasted and leached material was sent to the lead furnaces. A market for the recovered zinc sulphate has not yet been found. Lessees on the Sheridan crosscut of the Smuggler Union Co. treated ore from old stopes in the Perino 50-ton amalgamation-concentration mill. Lessees on the Liberty Bell, on which company operations had ceased in August, 1921, after successful operations since 1898, produced some gold amalgam bullion and some gold concentrate. The Tomboy Co. continued to operate steadily its 600-ton gravity-concentration and selective-flotation mill. The rough concentrate from the Wilfley tables was put through a bath of quicksilver in a slowly revolving tube mill. Recovery by amalgamation was satisfactory, though month to month recovery was erratic, owing to the changing character and gold content of the ore. Ore that had undergone much oxidation through long exposure yielded its gold to amalgamation less readily than ore more recently broken or ore from the dry parts of the mine. The annual report of the Tomboy Gold Mines Co. (Ltd.) for the year ending June 30, 1923, containing the report of the manager dated September 15, 1923, says:

A total gross of 233,114 tons was hauled from the mines to the mill. From this total 14,769 tons, or 6.33 per cent, were sorted out and discarded as waste, and 12,315 tons, 5.63 per cent, were deducted for moisture content, leaving, with a loss in bin storage of 116 tons, a net total of 206,146 dry tons milled.

A total of 74,703 wet tons, or 32.04 per cent of the tonnage sent to the mill, were drawn from the Argentine group.

No development work was performed during the year, and practically all floor pillar removal was completed above 1,650-foot level. At this date all drawing of ore on 1,750-foot level is completed and the stopes above emptied as far out as No. 123 chute. On 1,650-foot level the floor pillar was removed out to No. 126 chute.

Blocks left intact in the vein above the 1,650-foot level between No. 123 raise and No. 103 raise have been carefully examined and found too low grade to mine. Still farther out are two stopes remaining to be further examined, but it is doubtful if these will warrant further mining. At the inside end of 1,650-foot level a small stope was once started but abandoned because of the low grade of the ore, and further sampling of this shows it too low to warrant mining at the present time.

The last estimated ore reserves consist of 21,267 tons broken and 13,132 tons unbroken, or a total of 34,699 tons readily available from above 1,750-foot level. The estimated ore reserves below 1,750-foot level remain the same as a year ago, namely, 74,062 tons broken and 121,393 tons unbroken, or an additional amount which leaves a grand total for Argentine of 230,154 tons. Of this 195,455 tons are below 1,750-foot level, but very little can probably be drawn and milled at a profit under present-day conditions. During the coming winter, or dry season, as storage water is drawn from the lower levels, a generous amount of this ore will be hoisted and milled to determine conclusively whether or not it can be handled at a profit. A year ago it was expected that ore from above 1,750-foot level would be exhausted within the year, but to-day still another few months' run of the same percentage of total to mill is to be expected.

In the Montana group development driving in the Montana mine totaled 2,709 feet and consisted of 1,579 feet of drifting, 978 feet of crosscutting, and 152 feet of raising.

Of the drifting 988 feet and of the crosscutting 550 feet were on Montana level, making a total of 1,573 feet of drifting and 557 feet of crosscutting done on this level during the last two years, to prove the existence or nonexistence of ore bodies in the section of the mine to the north of No. 166 raise.

While this development work has quite thoroughly explored this level of the mine without developing other than the one ore body, 400 feet long by 100 feet in height, with an average width of 8 feet, this one block of ore will return the cost of all the Montana level development several times over. No further work on this level is contemplated except to complete the mining and drawing of the remaining ore.

The 1,750-foot level drift north of the Sidney vein crossing was extended a distance of 591 feet, following very well defined foot and hanging walls with about 4 feet of vein matter between but without encountering any ore. This drift is being continued, but to date the showing is not at all encouraging.

All other drifting was for haulage purposes around bad sections of the present main haulageway in the vein. The 152 feet of raising was all in the No. 166 manway above Montana level.

A total of 128,232 wet tons, or 55.01 per cent of the tonnage sent to the mill, were drawn from the Montana.

The last estimated ore reserves consist of 259,895 tons broken and 102,889 tons unbroken above 1,750-foot level, 26,513 tons broken and 58,469 tons unbroken below 1,750-foot level, or a total of 447,766 tons in Montana.

Preparations are now under way for the removal of the 84,982 tons below 1,750-foot level, but all of this will have to be hoisted, and considerable work remains to be completed before this tonnage becomes available, some six months or more hence.

In Montana (Virginius), development driving in the Virginius totaled 873 feet and consisted of 526 feet of drifting, 206 feet of raising, 51 feet of crosscutting, and 89 feet of sinking. With the exception of the crosscutting and sinking, which was done just outside of No. 1 chute on 1,750-foot level, all development in Virginius was carried on for the purpose of determining whether or not the ore shoot continued through and above 1,450-foot level to the Fortuna level between the No. 26 and No. 44 manways. It has been found that no payable ore lies above 1,450-foot level in this section, and it will probably prove unprofitable to carry the 1,600-foot stope through to the 1,450-foot level. All stoping has been discontinued between No. 1 chute and No. 26 manway, and at this date these stopes have been drawn practically empty. Some further stoping may be found profitable in the "Varsity stope," but the tonnage from this section will undoubtedly prove small.

As the Virginius ore body has been proved not to extend upward there remains a possibility that it may extend downward, and the drifting to be done on 1,900-foot level should soon throw interesting and definite light on this question.

The ore in reserve here is estimated at 11,256 tons broken and 22,788 tons unbroken, or a total of 34,044 tons.

During the past year 30,179 tons, or 12.95 per cent of the total sent to the mill, came from the Virginius.

As silver is the chief value in the Virginius vein, much of it must now be left in place that could be mined and milled at a small profit with higher silver price.

The total ore reserves in all three mines amount to 711,964 tons, of which 392,993 tons are already broken and 318,971 tons are unbroken.

In arriving at the estimate of ore reserves as of July 1, 1923, it has been necessary to assume that tonnages computed several years ago, when all stopes and levels were open and accurate measurements possible, were correct. Under ordinary conditions an exact statement of ore reserves should be a simple matter, as ore extracted during the year subtracted from the sum of the previous year's reserve and additional ore developed would give the figure desired. In this instance, however, an exact statement is impossible. Most of the stopes and levels are inaccessible for measuring and sampling, and there has been so much dilution of value by caving of wall rock into the ore, that what was once ore might now best not be called ore at all. As we have gradually retreated out of the Argentine we have at the same time been cleaning out and retreating from the best of the ore shoots, and only the very lowest grade ore remains. In a somewhat similar manner the same condition exists to-day in the Montana mine. Therefore, rather than accept the above figure, brought down from year to year, as correct, it would be much safer and nearer the true condition to assume that at best the ore reserves do not total over 300,000 tons of ore that can be mined and milled at a profit. It is, indeed, unfortunate that no definite assay value can be placed on this tonnage.

Following the policy decided upon by the Tomboy board the first of this year, in view of the lesser profits to be made during the balance of the life of the mines, as much development of previously unexplored territory has been carried on as

the finances of the company could stand. Such work is thoroughly consistent with good mining and if postponed, as is so often done, until all developed ore is exhausted, never would be performed. Under the present policy, when the ore already developed is exhausted, all possibilities of the property will have been thoroughly investigated.

No changes or additions have been made in the mill during the past year, but a slight improvement in recoveries has been effected.

During the last dry season water became very scarce, and this alone resulted in a slightly lower tonnage milled than during the preceding year.

Having carried the cleaning up of the old 60-stamp and site as far as was practicable with our own labor, this work was leased to some outsiders on a royalty basis and is bringing in a small additional amount of revenue.

Revenue and expenditure, year to June 30, 1923

	Per ton		
206,146 dry tons milled, yielding amalgam bullion worth			$248,598.64
Concentrates worth			691,615.51
			940,214.15
Sundry profit, boarding house, rents, etc			10,002.71
			950,216.86
Mining and development expenses	$1.80	$370,853.47	
Milling expenses	.59	122,369.57	
Concentrating expenses (including transportation to railway)	.66	135,991.34	
Water-supply expenses	.18	37,389.18	
Assay office expenses	.03	6,103.27	
General expenses	.32	64,288.26	
Taxes and insurance	.18	37,481.54	
Total expense	3.76		774,476.63
Profit			175,740.23

Since the writing of the last annual report the operations have completely recovered from the effects of the fire which occurred on July 8, 1922. All buildings have been rebuilt, all supplies and equipment replaced, and the book accounts closed, showing a total loss, uncovered by insurance, of $30,190.86. The new shops building, started just previous to the fire of last year, is completed and occupied and is proving a much more economical arrangement than the old, because of its central location and accessibility to the main haulageway.

SUMMIT COUNTY

The price of zinc allowed the Wellington zinc-concentration mill to be operated throughout the year. Dredges and other placer operations yielded $203,379 in gold and 2,472 ounces of silver, as compared with $255,298 in gold and 3,218 ounces of silver in 1922.

Breckenridge district.—The gross value of the output of the Breckenridge district from both deep and placer mines was $1,074,932, as compared with $350,723 in 1922. The Wellington gravity-concentration and magnetic-separation mill was operated almost continuously on zinc-iron-lead ores, making principally zinc concentrate, for which zinc smelters paid only for the zinc content, lead-silver concentrate, and iron-silver concentrate. From the Detroit lease, on the Detroit-Hicks and Missouri groups, were shipped lead-silver-gold sulphide ore, dry silver-gold ore, lead-silver oxide ore, and zinc-lead-silver sulphide ore. Small shipments of smelting ore were made from the June Bug, New Year, Sure Thing, and Standard dump.

Two dredges, three hydraulic mines, and three sluicing mines contributed to the placer-gold output. The Bemrose-Bostwick placer, on the Breckenridge side of Hoosier Pass, 10 miles south of Breckenridge, was operated by hydraulicking from July 1 to September 15. The Mekka bench gravel, below Breckenridge, was hydraulicked for about 60 days in the summer. The Washington placer, in Illinois Gulch, was hydraulicked for four months in the summer and fall. The Blue River Placer Mining Co.'s dredge of 88 buckets, of 8 cubic feet capacity each, on Blue River, 2 miles north of Breckenridge, was operated 12 months. The Tonopah Placers Co. operated its No. 1 dredge (equipped with buckets of 9½ cubic feet) for 229 days. The company furnishes the following statement for publication:

Production and income statement of Tonopah Placers Co. for the year 1923

Gross value of bullion shipped to mint	$119, 175. 37	
Cost of operation	117, 333. 68	
Dredge No. 1 operating profit	1, 841. 69	
Other income	2, 721. 96	
	4, 563. 65	
Additional charges	10, 131. 18	
Loss from operation (reserves not included)		$5, 567. 53
Reserves for year 1923:		
Depletion of mineral property	$2, 450. 00	
Depreciation of plant and betterment	9, 422. 43	
Depreciation of dredges	3, 186. 80	
		15, 059. 23
Net loss for year 1923		20, 626. 76
Cubic yards dredged		1, 228, 555
Gold produced	ounces	5, 716
Silver produced	do	1, 442
Value per yard		$0. 097

Consolidated Tenmile district (Frisco, Kokomo, and Robinson).—The Consolidated Tenmile district produced from five deep mines 2,758 tons of ore, carrying $5,472 in gold, 15,881 ounces of silver, 14,109 pounds of copper, 39,957 pounds of lead, and 29,800 pounds of zinc, with a total value of $25,391, as compared with $130,498 in 1922.

From the Michigan-Snowbank-Uthoff Tunnel group, at Kokomo, was shipped until June, during the maintenance of the Pittman Act price of $1 an ounce for silver by the smelters, over 2,000 tons of pyrrhotite ore, carrying 5.68 ounces of silver and 0.10 ounce of gold to the ton and a little lead and copper, to the Garfield smelter, Utah. A body of lead-zinc sulphide ore was then opened, but no market was found, so the mine was closed September 1. Small shipments of dry silver ore were made from the Golden Queen and Wintergreen mines, at Kokomo. Milling of lead-zinc sulphide ore from the old Wilfley property, at Kokomo, resulted in the shipment of several cars of zinc concentrate and several cars of lead-silver-gold concentrate. A car of lead-silver-gold ore was shipped from the Etta mine, at Frisco.

Montezuma district.—Eight mines in the Montezuma district produced 954 tons of ore, carrying $460 in gold, 15,237 ounces of silver, 1,932 pounds of copper, 176,157 pounds of lead, and 13,200 pounds of zinc, with a total value of $26,467, as compared with $19,343 in

1922. The producing mines were the Adder, Congress, Ida Belle, Pennsylvania, Philadelphia, Rothschild, and Comstock (Saints John Mines Co.).

TELLER COUNTY

Mine and dump ore, slags, slimes, concentrates, and stolen bullion from the Cripple Creek district aggregated in recovered gold to United States mints and smelters 195,774.01 fine ounces, valued at $4,047,008, as compared with $4,037,582 in 1922, and 22,606 ounces of silver, as compared with 24,462 ounces in 1922. The Golden Cycle mill, at Colorado Springs, a roast-amalgamation and cyanidation plant with a daily capacity of 1,200 tons, was operated steadily at about half capacity, entirely on ores from the Cripple Creek district, with the exception of several hundred tons of gold ore from Boulder County.

In the Cripple Creek district the Portland Gold Mining Co.'s Independence 800-ton cyanidation and concentration mill was operated on one shift during the entire year, and the daily average treated was slightly in excess of 400 tons. Observations made through the year indicate that the mill can be depended on to make an 80 per cent extraction on 750 tons a day. The operation of the Independence mill showed the following results, according to the annual report of the Portland Gold Mining Co. for the calendar year 1923.

	Dry tons	Gross value	Average value	Tailings loss per ton
Portland ore through "A" level	150,268	$498,454	$3.31	
Portland lessees through ore book	755	4,909	6.50	
Outside custom ore through ore book	102	240	2.35	
El Paso dump	239	544	2.27	
Dexter dump	1,014	2,497	2.42	
	152,378	506,644	3.32	$0.68

Recovery:		
Bullion		$353,713
Concentrates shipped		56,131
		409,844
Tailings loss for year		103,617
		513,461
Excess recovery over calculated contents for the year		6,817

The excess recovery can be accounted for in the difference in the value in the circulating solution at the beginning and ending of the year and the varying weight of the loaded cars on which the "A" level tonnage was estimated.

Statement of earnings of Independence mill, 1923

Total recovered as above	$409,844	
Miscellaneous earnings	1,393	
		$411,237
Operating expense, including marketing of concentrates	230,304	
Ore freight and mining expense	47,086	
		277,390
Total net recovery		133,847

To economically operate the No. 2 shaft we must hoist the largest tonnage possible there, and the results of the past year indicate we can expect a mill tonnage from the No. 1 and No. 2 shafts in excess of 400 tons per day. To produce the tonnage required for the Independence mill we will have to operate the Independence shaft and draw from it approximately 350 net tons daily. The old steam plant and screening plant there were operated at a prohibitive cost in the past. During the year we dismantled these plants, and at this time a simpler screening device is being installed and also a washer for the reject. The steam hoist is being electrified. This plan when completed, which should be about April 15, will be capable of producing the entire mill tonnage, if necessary, at a greatly reduced cost.

We have each month during the year drawn approximately 2,000 net tons of mill dirt from the various chutes in the Captain area. This material has averaged in excess of $3.75 per ton and can be produced through the Independence shaft at a cost not in excess of 80 cents per net ton.

Operating conditions at the mill have been excellent, and the results shown in the small tonnage treated are most gratifying. The physical condition of the mill, Kellerville pumping station, and tailing dams is very good. Two new electric compressors have been installed at the No. 2 shaft, and many changes and alterations made to the steam plant and water supply in the interest of economical operation. In the ore house the installation of grizzlies 45 feet long has made it possible to do away with ore sorters, at a large monthly saving to the company.

In Poverty Gulch several thousand tons of ore was shipped from the El Paso-Gold King mine.

On Tenderfoot Hill one small shipment was made from the Queen Bess mine, and several cars were shipped from the Sangre De Christo Tunnel group.

On Globe Hill lessees from the Stratton estate shipped several lots of ore from the Deerhorn and other claims.

On the north slope of Ironclad Hill the producing mines were the Forest Queen, the Jerry Johnson, the Sol Cain lease at Midway on the western part of the Wild Horse group (see Bull Hill), and the Hardwood (or Damon) snd W. P. H. groups.

On Gold Hill all the mines were idle.

The shipping of the dump of the Economic mill, at the foot of Squaw Mountain, continued through 1923.

On Raven and Guyot hills the producing mines were the Cresson, Doctor-Jackpot, Elkton, and Mary McKinney. The Doctor-Jackpot was operated under lease. The Elkton mine was operated by the Elkton Mining & Milling Co. until May 20, 1923, when it was taken over by the First National Bank of Cripple Creek and operated for the remainder of the year by lessees. The Mary McKinney mine was operated throughout the year. The Cresson mine continued to be the mainstay of the Golden Cycle mill. Shipments were made at the rate of 10,000 tons a month. The annual report of the Cresson Consolidated Gold Mining & Milling Co. for the 12 months ending August 31, 1923 (dated December 18, 1923), says:

During the year 123,734 dry tons of ore were shipped of a gross value of $1,883,138, averaging $15.22 per ton; the returns, less transportation and treatment, were $1,243,706, giving the ore a net value of $10.05 per ton. The company received as additional income the sum of $3,638, being net royalties from 437 tons of ore shipped by lessees, and also $10,576 interest on bank deposits, making a grand total of $1,257,920 with total expenses of $609,696, resulting in a net gain from operations of $648,224. The total cost per ton of ore produced was $4.93. This is an increase of 1 cent per ton over 1922, but our broken-ore reserve is much larger than a year ago.

You will note in our company's production of 123,734 dry tons, with an average return of $10.17 per ton, our entire cost was $4.93 per dry ton, resulting in a net profit of $5.24 per ton.

Total cash at the close of the fiscal year ending August 31, 1923, was $781,529.

The total cost of mining is divided as follows:

General expense	$0.011
Taxes	.336
Insurance	.098
Salary officers	.070
Colorado Springs office	.075
Mining operations (includes mine management and engineering)	4.340
	4.93

Our broken-ore reserve is the largest in several years, and during the year more waste was hoisted because of extensive development than ever in the history of the mine.

At this date, December, 1923, the crosscut on the eighteenth level is near the ore zone, and with favorable development here it is planned to sink the shaft to greater depth.

During the past year the mining situation in the Cripple Creek district has shown substantial improvement. With the return to normal conditions the labor turnover is nominal, and your company is now operating with a full complement of competent and experienced miners.

The following is a summary of the company's operations for the year ending August 31, 1923:

	Feet
Drifts and crosscuts	3,735
Raises and winzes	1,293
Ore raises	635
Shaft sunk	179

In addition to this, cut-outs and ore shoots have been made in a continually extending ore area.

The repairs to head frame, hoisting equipment, and steel ore and waste bins have been finished, also stoker, boilers, etc., installed, giving ample hoisting power for the needs of the existing shaft.

The development work was much hampered during the summer months by labor shortage. (At time of writing there is ample labor supply.)

The shaft sinking, water handling, pocket and station cutting curtailed the prospecting work, even in places already showing interesting one-dimension ore.

Stope 1111 remains one-third full of broken ore. The small stopes 1203–1303, 1309, 1318, 1400 W., and 1503 are completely drawn. Stope 1603 remains one-half full of broken ore. 1612 remains two-thirds full of broken ore. 1407 raise is broken clear through to twelfth level, and stope is extending toward twelfth level, giving promise of extending on upward to the eleventh level.

1612 crosscut stope remains full of broken ore.

New stope 1620, opened in March, 1923, has been broken on shrinkage system for 50 feet and should continue to fifteenth level.

New stope 1625 is extensively opened and also broken to 30 feet above level. On seventeenth level a new stope 1712 developed but later proved to be part of the 1704–9–12 system. All these have combined as one stope, which is full of broken ore for 100 feet of the 153 feet between sixteenth and seventeenth levels.

Winze 1709 under this system has been sunk 65 feet in good values, where the water reached the capacity of the small sinker pump being used. The shaft on August 31 had reached a depth of 179 feet below seventeenth level, and a new station was being cut 125 feet below the seventeenth. The pumps were handling 150 gallons a minute each at shaft and winze. This has since decreased to about 100 gallons each.

While the greater part of our late development work has been on the three lower levels, there still remains much good country to be explored above. This will have to stand until opportunity presents.

Since August 31 we have continued the ordinary ore-development work above the tunnel, including a new large shaft ore pocket at 1700. The station on eighteenth level has been made more complete and spacious than those above, and the position left clear to continue sinking. Larger cars are to be installed on 18 to lower tramming costs.

Pump station, a 25,000-gallon pump sump, and two 300-gallon electric pumps with power line are installed, and the base in place for a third. The main heading, 7½ by 7½, has been driven 160 feet in direction of main ore bodies.

Production of the Cresson mine, 1903 to December 31, 1923

Period	Dry short tons	Gross value	Freight and treatment, including war tax	Net value	Average gross value per ton	Average net value per ton	Dividends
1903 to Aug. 31, 1923	1,102,444	$23,122,692	$6,282,229.30	$16,840,462.70	$20.97	$15.28	
1903 to Dec. 31, 1923		23,773,862					$9,922,273

On Beacon Hill small shipments were made from the El Paso and Gold Dollar mines.

On Bull Hill the producing mines were the Blue Bird (Buckeye Co.), Dante, Dexter (from the dump only), Last Dollar, Stratton estate (from the dumps only of the American Eagles, Orpha May, and others), and Wild Horse.

Producing mines between Altman and Goldfield were the Burns (Acacia Co.), Bison, Pinto, Delmonico (Free Coinage Co.), Deadwood (United Gold Mines Co.), Empire Lee (formerly known as the Isabella), Victor, and Vindicator-Golden Cycle group, of which the last was worked by the United Gold Mines Co. During 1923 the Findley and Mountain Beauty mines were acquired by the United Gold Mines Co.

On Battle Mountain the producing mines were the Ajax, Big Banta, Bonanza, Granite, Portland-Independence group, Rose Nicol, and Strong. The Tonopah Ajax Mining Co.'s operations on the Ajax mine were practically continuous (331 days), and the work done amounted to 8,500 feet of development. This company at depth found veins apexing in United Gold Mines Co. ground and leased that area, paying a royalty on ore extracted. The claims are known as the New Market and Big Theatre. The annual report of the Portland Gold Mining Co. for 1923 says:

During this year the shaft was sunk to the 2,722-foot level and a pumping station cut out which will be used permanently. It is at the limit of our three Buffalo pumps. In addition to these pumps we purchased during the year and have installed on this level a Lecourtenay five-stage centrifugal pump, which has a capacity of 1,000 gallons raised 1,000 feet per minute. This level is also provided with a steel water door to guard against the possibilty of drowning our pumps by any sudden influx of water. The pump sump on this level has a capacity of 55,000 gallons of water, and the pumps are set high enough above the level to provide for an equal storage in the level itself. There have been many erroneous reports as to the water conditions on this level. It is true that we have taken more precautions against the water than we have heretofore, but our depth is greater, and it was logical to do so. The flow, which is less than 1,000 gallons per minute, is no greater than it was on 2,450 and 2,600 and is being handled by the same pumps that were used on 2,600, the Lecourtenay being held in reserve.

Up until October 1 we were making a fair profit each month and would have continued to do so had it not been for a cave-in on 2,600 which for a period of three months cut us off entirely from our principal ore supply and resulted in a serious loss. It will be recalled that on 2,600 north we encountered six new cross veins which intersected the No. 1 and Lee 5 veins and ran off to the northeast into the breccia. These spur veins were very close together, and as a result of the drifting and stoping on them the area between them, which was cut by numerous small slips and seams, was weakened to such an extent that the timbers failed to hold the ground. Had the existence of these veins been anticipated, we

could have provided against it, as has been done on the 2,700 level. Fortunately this ground was caught up late in December, and the 100,000 tons of broken material above made available.

During the year it also became necessary for us to make permanent repairs to the Roosevelt drainage tunnel, and this work was completed in December. The Cresson Gold Mining Co. carried 60 per cent of the expense of this work, the balance being paid by your company. All caved and timbered areas in the tunnel are now supported by 10-inch reinforced-concrete arches. This work was done under the greatest difficulties and involved the operation of the Elkton shaft and the laying of approximately 2,500 feet of track under water. However, it has made permanent the drainage system of the camp.

The development of the 2,700 level to date has been extremely gratifying. The crosscut encountered the vein at a point well north of the shaft and cut the ore. At the time of preparing this report, February 8, we have drifted on approximately 200 feet of ore in the No. 1 vein and on approximately 100 feet on each of two cross veins—400 feet in all. The north breast of the No. 1 vein is still on ore, and the breasts of both cross veins are still in excellent ore. The south drift on No. 1 vein is practically through the horse which has at all times divided the north and south ore bodies, and this breast is beginning to show some values. We have encountered two more cross veins which will be developed as soon as it is practical. The No. 1 east cross vein is making an exceptional showing. This ore body to date is over 100 feet in length, and the last 50 feet is in excess of 12 feet in width.

The influence of the ore bodies on 2,700 has already been shown in the grade of ore shipped, which during January averaged $38.94 per ton, although diluted by the lower-grade material from 2,600, and in the Independence mill the heads in January had averaged $4.96 for the month.

While developments in the south drift on 2,600 were disappointing, we have many reasons to expect that 2,700 will show a return of values in that portion of the mine.

On February 15 we will start sinking the shaft. It is our plan to sink approximately 270 feet and cut a pump station and sump there. An intermediate level at approximately 2,860 feet will be opened. This work will probably require from ten to twelve months. We also plan to drive the "A" level into a point opposite the No. 2 shaft, so that we can abandon the Scranton chute and make direct haulage from the raise under the ore house.

It is a matter of great disappointment to me that the end of our fiscal year did not find us out of debt. Only our difficulties on 2,600 prevented this. However, the situation on 2,700 is such that I am very confident in predicting that this condition will be brought about within the next few months.

The United Gold Mines Co., controlling properties in various parts of the Cripple Creek district, but with principal production from those claims on Battle Mountain, in its annual report for the year ending December 31, 1923, says:

During 1923 the Findley and Mountain Beauty properties were acquired by payment of stock of your company. Since the Findley was taken over a settlement of its apex litigation with the Stratton estate has been made by purchase of the apex right by the Stratton estate.

Nearly 2 miles of drifting and prospecting has been done by lessees and on company account. This resulted in opening up small ore shoots, but the only profitable ones were on ground leased to the Tonopah-Ajax Co. and on the Big Banta claim, which is wo rked on company account.

The Tonopah-Ajax Co., leasing on the New Market and Big Theatre claims, discovered on three levels new ore bodies, which have been named the New Market vein system, and large production from this new ground is reasonably assured. As this ore was found at great depth through the Ajax shaft, it was considered advisable to lease it.

The ore body on the Big Banta, although of small dimensions, has been of high average value. In the same country at the same elevation we are developing a large body of low-grade ore, which is shipping about $10 per ton as mined.

The Wild Horse group, on which a bond and lease has been granted, is being equipped to work the lower levels.

The Cain lease, near the Wild Horse, is shipping ore from a small chute.

The Vindicator and Theresa are both being operated by the company, but the work is almost all done on a 50 per cent division of the net returns with the lessees. Some diamond drilling is being done.

Other parts of the property are leased, but the showing for any great volume of ore is not encouraging.

Total production of United Gold Mines

	Net tons	Gross value
Ore mined before consolidation	26,310.038	$456,806.19
Produced under United Gold Mines Co	313,458.044	5,481,328.58
	339,768.082	5,938,134.77

Production of the United Gold Mines for the year 1923

Group	Dry tons	Gross value	Royalties	Company ore	Lessees	Average per ton
Bonanza	96	$3,916	$1,086		$2,047	$40.97
Deadwood	610	13,710	2,343		7,221	22.47
Hardwood	304	3,357	58	$1,361	394	11.04
New Market	1,102	23,782	2,880		13,865	21.57
Requa	2,382	81,822	2,042	60,473	2,264	34.35
Vindicator	28,668	341,479	73,737	33,038	112,294	11.91
Wild Horse	1,182	21,490	2,721		10,704	18.19
W. P. H	34	333	20		143	9.90
	34,378	489,889	84,887	94,872	148,932	14.25

Development for the year 1923

	Feet
Deadwood group:	
Deadwood Leasing Co	125
W. S. Moore	520
Hardwood group:	
L. S. Cox	314
Dworak & Kellum	75
Company	36
Requa group: Company-Big Banta	566
Vindicator group:	
Lessees	3,884
Company	3,276
Wild Horse group: Sol Cain	324
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